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BARK-BEETLE EPIDEMICS AND RAINFALL DEFICIENCY

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ABSTRACT

The periodicity of bark-beetle epidemics is one of the most interesting phenomena connected with their occurrence. The successful application of control and preventive measures is, to a considerable extent, dependent on the entomologist's ability to foresee an increase or a decline in the existing status of the infestation. Epidemics of the southern pine beetle, which is the chief consideration in this paper, are characterized by 1 to 3 years of intense acitvity. During the longer intervening periods the insects are extremely rare. Precipitation records for a number of localities throughout the Southeast have been tabulated and compared with the occurence of epidemics of this insect. There is an apparent correlation between deficiency of rainfall and the abundance of this insect in destructive numbers. Heavy precipitation while the young broods are developing under the bark produces a very heavy and effective mortality.

The occurrence of bark-beetle outbreaks has been recorded by Dr. Hopkins and other entomologists of the Division of Forest Insects for more than 30 years. A considerable amount of data is now available indicating that these epidemics are characterized by a certain periodicity. The determination of the causal factors responsible for the increases and declines will be of great value in the application of control and preventive measures.

Drought periods have frequently been suggested as the most important single factor influencing outbreaks of these beetles. This theory is especially applicable to the southern pine beetle, epidemics of which are characterized by from one to three years of intense activity. During the longer intervening periods the insects are extremely rare. Three widespread outbreaks of this species have occurred in so-called drought years. With some of the western species of Dendroctonus the transition from endemic to epidemic status is not so marked and annual surveys on the same forest over several years are required to obtain definite data. Precipitation records are also less available in that the Weather Bureau stations are widely separated and rarely located near the forests. Several

entomologists are working on this problem in the West and their results will be available in the near future.

In order to determine if any relation exists between the occurrence of the southern pine beetle in destructive numbers and deficiencies in rainfall, all outbreaks since 1890 have been tabulated and compared with the precipitation as recorded by the Weather Bureau at near-by stations, or, in case of more general outbreaks, for entire regions. For the sake of brevity only some of the more important epidemics and the rainfall during the corresponding years are considered in this discussion. A complete record of these outbreaks is available in the Bureau of Entomology files.

Historical

Few papers dealing specifically with this subject have been published. The more important papers are by Hopkins, Felt, and Blackman.

Hopkins,[1] after discussing at considerable length the influence of drought on bark-beetle epidemics, concludes, "It is evident therefore that drought is not an important factor in contributing to the multiplication or destructiveness of this class of insects." He does note, however, that an exception may exist in the case of the Douglas fir beetle in the southern Rocky Mountains.

Later Felt[2] shows that a deficiency in rainfall existed during an outbreak of the hickory bark-beetle near New York City.

Blackman[3] recently published a most important contribution not only showing that a deficiency of rainfall stimulates a destructive increase in the hickory bark-beetle but also that an excess of rainfall definitely checks their aggressiveness. He also advances reasons for these effects, as follows: "When the adults are active, continued rain kills many while feeding and establishing their burrows and also checks egg-laying. Excess rainfall, humidity and cloudiness kills the larvae because it produces an excess of water in the plant tissues and this is set free into the larval mines. Deficiency in rainfall has a beneficial effect upon both adults and larvae."

Seasonal History of the Southern Pine Beetle

A brief description of the seasonal activities of the southern pine beetle may assist in the interpretation of the following discussion. Throughout the Piedmont region and the northern portion of the Coastal

[1]Hopkins, A. D. Barkbeetles of the Genus Dendroctonus. Bul. 83, Pt. I, Bureau of Entomology, U. S. Dept. of Agric. 1909.

[2]Felt, E. P. Notes on Forest Insects. Journ. Econ. Ent., Vol. 7, pp. 373-375.

[3]Blackman, M. W. The Effect of Deficiency and Excess in Rainfall Upon the Hickory Barkbeetle. Journ. Econ. Ent., Vol. 17, pp. 460-470.

Plain two or three generations develop each season. First emergence occurs in early May, though the main flight and attack take place between May 15 and June 1. A second period of concentrated attack occurs during August and September. In the southern portions of the Coastal Plain, particularly in the Gulf States, as many as 5 or 6 generations may occur so that, owing to overlapping of generations, there is even a less pronounced period of general attack. Emergence begins about a month earlier than in the Piedmont region and continues into November. Rain or drought during these periods of activity appears to have a more pronounced effect than during the winter months.

Southern Pine Beetle Outbreaks and Precipitation

Since 1890 three general outbreaks of the southern pine beetle have occurred, centering in the years 1891, 1911, and 1922; in addition, many more local infestations have been reported. The more important of these are as follows:

The Great West Virginia Epidemic of 1891–1892. The first general outbreak of which we have any authentic knowledge occurred in West Virginia in 1891 and 1892. Dr. Hopkins has described this in detail.[4] First reports of injury were received in March, 1891 (which indicates that some trees were attacked in the preceding fall). During the summer of that year and through 1892 the epidemic progressively increased, killing great quantities of yellow pine, as well as spruce and white pine. Dr. Hopkins reported the epidemic as occurring in the following counties: Hampshire, Grant, Mercer, Webster, Summers, Pendleton, Greenbrier, Hardy, Pocohontas, Tucker, Randolph, Mineral, Raleigh, Doddridge, and Monongalia. Several counties in Virginia were also mentioned (Bath, Highland, Augusta, and Rockingham) and reports of dying trees were received from adjacent counties of Maryland and Pennsylvania. Whether this outbreak extended farther south in Virginia or into the Carolinas is not known, but from interviews with older residents in the Great Valley of Virginia it is likely that this section was attacked as well.

During the year 1893 Dr. Hopkins again visited the localities where his studies of the previous year had been conducted. He states that practically nowhere was he able to find any recently infested trees, and many of those heavily attacked in the late summer of 1892 were still green, the broods having failed to develop. To quote from Dr. Hopkins (above citation), "Upon felling and examining some of the trees that had died

[4]Hopkins, A. D. 1899. Report on Investigations to Determine the Cause of Unhealthy Conditions of the Spruce and Pine from 1890–1893. Bul. 562 W.Va. Agric. Exp. Sta.

the previous fall and others that were then dying, I found upon removing the bark, that in every case all stages of the destructive bark-beetle were dead, and where there were a great many larvae in the bark, the odor from their decaying bodies was very perceptible." In summarizing his observations, he states, "I had found the destructive species dead in the trees in the northern part of the State, and here the same condition was found in the opposite or southern portion which indicated that possibly the species had been exterminated throughout the State." In the fall of 1893 a notice was sent to the principal timber owners containing the following: "It may be of interest to your readers to learn that the serious trouble, which in 1890–92 threatened the entire destruction of the valuable pine and black spruce forests in West Virginia and adjoining States is entirely over. * * * I am all the more convinced that this is so from the fact that I have not been able to find a single living example of the destructive pine bark-beetle (*Dendroctonus frontalis*) in the State since the spring of 1893."

In looking for causes for the sudden decline of this epidemic Dr. Hopkins believed that the severe low temperatures of the winter of 1892–93 caused the death of these beetles. This may have been in part responsible, but the fact that the broods of the late summer attack failed to develop in many places indicates that they died earlier in the year.

At the time of this outbreak very few stations existed where rainfall was recorded. In fact, no records are available from any of the localities where the infestation was reported as centering. Those stations in West Virginia where records are available, however, show a general deficiency for the years 1890, 1891, and 1892 as illustrated by Harpers Ferry, Martinsburg, and Hinton. These deficiencies likewise occurred in the summer during the period of brood development. Throughout the Valley of Virginia, drought likewise prevailed in these years.

Western North Carolina, 1902–05. The earliest report of an outbreak in this region was received in May, 1902, near Tryon, Polk Co., N. C. Mr. W. F. Fiske inspected the trees and spent considerable time in this locality and surrounding points between 1902 and 1906, and from his records the following notes are taken.

In 1902 pines dying from the attack of the southern pine beetle were found near Fletcher, Henderson Co., as well as at Tryon. The following year infestations were noted on Pisgah Ridge between Haywood and Transylvania Cos. Beetles were present and apparently increasing at these points of observation until April, 1906; timber in the vicinity of Charlotte, Mecklenburg Co., was also found infested. Letters of Mr.

Fiske dated April, 1906, indicate that practically no living beetles could be found and later references during the summer confirm this view.

The nearest Weather Bureau stations recording rainfall were at Caroleen and Hendersonville. Monthly precipitation for Caroleen is given for the years 1902 to 1905 inclusive, in Table I. Here in 1901 an annual

TABLE 1. PRECIPITATION DEPARTURES AT CAROLEEN, N. C. 1902 TO 1905.

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1902	— 1.95	+ 3.29	+ .64	— 1.21	— .46	+ .09	— 2.54	— 3.51	+ 2.05	— .21	+ .74	— .66	— 4.53
1903	+ 1.53	+ 5.14	+ 4.37	+ 1.09	— 2.54	+ 5.74	— 5.23	— 2.21	— 1.86	— 2.45	— .02	— 3.70	— .94
1904	— 1.84	— 1.15	— 1.01	— 1.88	— .68	— .32	— 1.44	+ 2.00	— 3.06	— 3.48	+ 1.64	— 1.60	— 13.62
1905	— .43	+ 1.23	— 3.68	— .72	+ 1.21	— 3.80	+ 1.35	+ 1.56	— 1.83	— 1.47	— 1.73	+ 3.45	— 5.66

excess of 22 inches is recorded; 1902 shows a deficiency of 4.53 inches with 5 of the 7 months between April and October below normal. A deficiency of only 0.9 inch occurred in 1903, but the early part of this year was very wet while the summer, fall, and winter were marked by a decided drought, extending almost continuously through the following year (1904), the latter with a total deficiency of 13.6 inches. Again 1905 is below normal by 5.6 inches. This year, however, the months of deficiency and excess were well distributed though an excess of 3 inches occurred in July and August, the time of maximum attack of the second generation. During 1906 an excess of over 6 inches occurred well distributed through the summer season.

Hendersonville received much the same character of rainfall as shown by the following: In 1901 an excess of 30.4 inches; in 1902, 1903 and 1904, deficiencies of 11.4, 2.2, and 1.3 inches while in 1905 an excess of 7.0 inches occurred, chiefly during the months of May, June, July, and August.

The records for Charlotte are also very similar. They are as follows: In 1901 an excess of 13.6 inches; in 1902 a deficiency of 3.9 inches; in 1903 a deficiency of 9.7 inches; in 1904 a deficiency of 7.3 inches; in 1905 a deficiency of 6.8 inches, though in this year an excess of over 5 inches occurred during May, July, and August; in 1906 an excess of 0.5 inch.

This is one of the two epidemics (compare Unaka National Forest, Tenn.) which extended over a four-year period and in both cases deficiencies in rainfall occurred over the same number of years.

THOMASVILLE, GA., 1904–05. Mr. W. F. Fiske visited this locality in June, 1906, and reported many dead trees showing the work of *Dendroc-*

tonus frontalis. In a letter, June 4, 1906, he states: "Many trees were killed in 1905 by the early brood but none found from which hibernating or spring broods (of this year) emerged." The precipitation for Thomasville, Ga., is as follows; in 1903 an excess of 9.5 inches; in 1904 a deficiency of 17.0 inches; in 1905 an excess of 5.3 inches occurring in May, June, August and September; in 1906, an excess of 2.2 inches. The 1905 summer excess probably destroyed the summer generations.

VIRGINIA BEACH, VA., 1907–08. During the summer of 1907 a rather severe though local outbreak of the southern pine beetle developed in the vicinity of Virginia Beach, Va. Control work was instigated in 1908 and by the following season the outbreak had completely disappeared.

Rainfall records for the nearest Weather Bureau station are as follows: Deficiencies occurred from September to December in 1906, and 1907 was a very dry year, practically 13 inches below the mean, with only one month (November) of normal rainfall. The following year (1908) shows a deficiency of nearly 6 inches but excesses are recorded for March, May, and August.

UNAKA NATIONAL FOREST, TENNESSEE AND VIRGINIA, 1913–16. First reports of this outbreak were received in February, 1914, describing clumps of trees killed the previous summer on Iron Mountain. Dr. T.E. Snyder examined this area in the summer of 1914 and 1915, spending considerable time in studying the character and extent of the infestation. From his notes the following summary is taken: Trees dead at the time of the first examination indicated that the first trees were killed in late summer of 1912 or early in 1913. During the summer of 1914 over 2,000 trees (chiefly yellow pine) were infested in groups of various sizes and well scattered over the national forest and the surrounding privately owned land in an area about 20 miles long by 10 miles wide. These groups occurred on top of ridges and south slopes, at elevations of between 2,000 and 3,500 feet. A considerable part of the infested trees were treated in the early spring of 1915. Fall examinations revealed some 100 trees killed during the summer of 1915. In the fall of the following year no infested trees could be found.

One Weather Bureau station is located in near proximity to this infested area at Mountain City, Tenn. From records at this place, Table 2, it can be seen that 1912 to 1916 were all years of deficient rainfall. During 1914 and 1915 deficiencies of 8.3 and 13.0 inches, respectively, occurred and in each of these years only one month during the growing season shows an excess. The control work of 1915 was reported to be very thorough and probably checked an otherwise great increase later in

TABLE 2. PRECIPITATION DEPARTURES AT MOUNTAIN CITY, TENN. 1913 TO 1916.

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1912	— 1.01	— 1.11	+ .78	+ 1.52	+ 1.19	— 2.52	— .20	— 1.20	+ .81	— 1.38	— .55	— 1.79	— 5.76
1913	— .34	— .93	+ 2.59	— .87	+ 2.15	— 1.78	— 2.12	— .50	+ .66	— 1.24	— .50	— 1.48	— 4.55
1914	— 1.74	+ .08	+ .68	— 1.08	— 2.21	— 2.92	+ .80	— .53	— 1.90	— 1.24	— .29	+ 1.81	— 8.33
1915	— .40	— .98	— 3.41	— 1.30	— .12	— 2.69	— 2.73	— .03	+ .57	— 1.76	— .59	+ .71	— 13.02
1916	+ .56	— .36	— .59	— 2.45	— 1.54	— 2.63	+ 2.63	+ 2.25	+ .34	— .46	— .29	— 1.76	— 4.99

that season, since even following control a number of trees were killed that summer. In 1916, when the infestation completely died out, three months of heavy precipitation occurred in July, August, and September, with an excess of about 5 inches during these months.

THE SOUTH CAROLINA EPIDEMIC OF 1911. During the late summer of 1910 reports were received calling attention to dying pines in South Carolina. By fall all indications pointed to a general outbreak of the southern pine beetle. The following spring a field station was located at Spartanburg, S. C., the apparent center of the outbreak, and many of the infestations throughout South Carolina, North Carolina, and Georgia were examined. This outbreak was centered in the western portion of the State, bordering counties of North Carolina, and in northern Georgia. It developed into extensive proportions during the summer, destroying up to 50 per cent of the finest timber in many localities. The counties where infestations were reported are as follows: Oconse, Pickens, Greenville, Anderson, Spartanburg, Cherokee, York, Newberry, and Lexington, in South Carolina; Transylvania, Henderson, Polk, Rutherford, Cleveland, Gaston, Mecklenburg, and Anson, in North Carolina; Habersham, Walker, Gordon, Chattanooga, Fulton, and Newton, in Georgia.

Dr. Snyder's notes during the late summer of 1911 and spring of 1912 record detailed observations on the condition of the bark-beetle broods. It is clearly evident that this outbreak died out just as suddenly as was the case in 1892 in West Virginia. Many trees attacked by the late summer broods of 1911 recovered, the attacking beetles were killed, and the broods failed to develop. It was difficult to find living insects during the summer of 1912 and no further dying trees were observed.

Since this epidemic was of a more general distribution throughout the

western portion of the state as well as bordering states north and south, the precipitation for the entire state is used as an illustration. Local conditions of course varied but in general the precipitation is much the same. A deficiency occurred during the fall and winter of 1909–10; the same being the case in the fall and winter of 1910–11, and through the early summer of 1911. After September a decided excess is shown which continues through the winter and following spring. See Table 3.

TABLE 3. PRECIPITATION DEPARTURES FOR THE STATE OF SOUTH CAROLINA, 1909 TO 1912

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
	—	—	+	—	+	+	—	—	—	—	—	—	—
1909	1.79	.13	.90	.20	1.13	2.00	.85	1.40	.16	.52	1.40	.77	3.19
	—	+	—	—	+	+	+	—	—	+	—	—	—
1910	.39	.19	2.48	1.53	.33	2.52	.09	.31	.72	1.22	1.36	1.27	3.71
	—	—	—	+	—	—	—	—	—	+	+	+	—
1911	1.73	2.89	1.55	.13	2.87	1.64	1.90	.50	.63	2.75	1.03	1.58	8.22
	+	+	+	+	+	+	—	—	+	—	+	—	+
1912	1.61	1.50	2.99	1.42	.56	.62	.47	2.86	1.95	.93	.44	.48	6.30

GENERAL EPIDEMIC OF 1922–23. For several years preceding 1921 practically no reports of the southern pine beetle were received from anywhere in the South. In the fall of 1922, however, it was realized that a rather general epidemic was developing. During the following year authentic evidence of the presence of this beetle was received from practically every state from Virginia south to Texas. Although in very few states or counties did this epidemic assume anything like the proportions of the 1910–11 outbreak in South Carolina, yet it was no doubt more general and widespread. The greatest injury perhaps occurred in Virginia, particularly in the western and southwestern portions of the state.

Very few localities were visited by entomologists, but at Laurel, Miss., and near Covington, Va., some detailed observations were obtained.

TABLE 4. PRECIPITATION DEPARTURES AT LAUREL, MISSISSIPPI.[1] 1921 TO 1923.

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
	—	—	+	+	—	—	—	+	—	—	—	—	—
1921	.67	.83	6.12	6.70	2.87	3.44	4.61	1.04	1.12	1.86	2.00	2.47	6.01
	—	+	+	—	+	+	—	—	—	—	—	—	—
1922	.63	.72	2.67	1.19	.28	1.54	.93	2.64	3.05	1.77	1.77	.24	7.01
	—	+	—	+	+	+	—	+	—	+	+	+	+
1923	2.38	.66	.53	2.75	9.29	3.51	1.39	.75	1.11	1.96	3.48	3.23	20.12

[1]Values for Sept., Oct., and Nov. 1921, June, July, August, and Sept., 1922, and Jan. 1923 are based on the average of two nearest stations, Hattiesburg and Shubuta, Miss.

LAUREL, MISS. Mr. R. A. St. George made an examination of the dying pine at this point in September, 1923. He reports that at this time no living broods of the beetles could be found but that many trees had been killed the preceding year and in the spring of 1923. Table 4 gives the monthly departures from normal precipitation for the years 1921 to 1923 for Laurel, Miss. Both 1921 and 1922 show deficiencies of 6 and 7 inches, respectively, occurring chiefly during the late summer and fall. In 1923 an excess of 20 inches is reported, with very heavy rains during April, May, and June, the period of brood development of the first generation.

SOUTHWESTERN VIRGINIA. First reports of dying pines were received in the fall of 1921, but it was not until the summer of 1922 that local outbreaks developed serious proportions. In the northern part of the valley outbreaks were scattered and extremely local but farther south in the vicinity of Covington, Roanoke, Natural Bridge, and the intermediate country few stands over 30 years of age escaped. The outbreaks were uniformly on southerly exposures and high ridges, usually starting at higher elevations and working down. Throughout this region 25 to 40 per cent of the pine, by volume, was destroyed, table-mountain and Virginia pine suffering most. During March and April, 1924, the writer examined several infestations in the neighborhood of Harrisonburg, Va., Wardersville, W. Va., and the three towns previously mentioned. It was possible to find but few living beetles, particularly in the more southern localities. Great numbers of trees were attacked in August and September of 1923 but in all cases the beetles were drowned out after making their egg tunnels, and the eggs either failed to hatch or the young larvae died soon after hatching.

Table 5, giving departures for the region surrounding Covington, indicates the drought conditions which prevailed until August and September, 1923. In these months an excess of nearly 3 inches occurred during the time of maximum late summer attack and brood development. At some stations this excess was over 5 inches.

ASHLAND AND ACCOMAC, VA. Two outbreaks of the southern pine beetle, one at Ashland and another at Accomac, Va., were reported in 1922 and examined by Dr. T. E. Snyder. Both of these were in loblolly pine and in both cases the beetles entirely disappeared the next season. The nearest weather stations recorded excess rainfall during the summer of 1922, though the preceding summer was dry. These two cases are decided exceptions to some 20 other localities where outbreaks occurred and where weather records were available, though in reality these outbreaks may have developed the preceding summer.

TABLE 5. PRECIPITATION DEPARTURES AT STATIONS* SURROUNDING COVINGTON, VA. 1920 TO 1923

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1920	— 1.05	+ .34	— .65	+ .14	— 1.37	+ .18	— .64	+ 2.70	— 1.02	— 3.31	+ 2.82	— .31	— 2.17
1921	+ .19	— .67	— 1.82	— 1.08	— .71	— .94	+ .34	— 1.95	— .44	+ .24	+ .82	— 1.24	— 7.10
1922	+ .38	+ 1.14	+ 2.12	— .53	+ 1.11	+ .03	+ .17	— .94	— 2.08	— 1.26	— 1.97	+ .77	— .04
1923	— .18	— .48	+ .77	— .07	— 1.64	— 1.62	— .55	+ 2.22	+ .56	— 1.68	— .67	— .52	— 2.43

*Catawba Sanatorium, Buchanan, Roanoke, and Lexington.

CONCLUSION

Every outbreak of the southern pine beetle since 1890, other than the two exceptions noted, has occurred during periods of rainfall deficiency, which suggests an intimate relation between these epidemics and drought periods. Furthermore, many observations indicate that these outbreaks originate locally on the higher points of southern exposure or drier situations from which points the beetles spread as they increase in numbers.

Late summer and fall deficiencies seem to be more important in developing epidemics than those at other seasons, and heavy precipitation during the periods of attack and brood development seem to be most effective in control by killing the beetles and the young larvae beneath the bark of the attacked trees.

The reasons for the greater susceptibility of trees during drought periods and the destruction of the broods with increased precipitation present an interesting problem for further study. Preliminary observations and experiments with felled, girdled, fire-scorched, and defoliated trees indicate that these effects are the results of the varying water content of the trees.

If this theory is tenable it will involve the assumption that these southern pines at any particular locality are closely adjusted to the normal precipitation which occurs in that region, though the species throughout their native range do well under a wide variation of rainfall.

MARKING HONEYBEES FOR BEHAVIOR STUDIES

By Ralph L. Parker

Abstract

Three good methods of marking bees are, the use of a thick oil paint (artist's colors); powdered pigment, white shellac and alcohol; and a varnish enamel. The most satisfactory one is the use of one part dry pigment mixed with one part liquid white shellac and diluted to the right consistency with ethyl alcohol.

A method of identifying the individual bees being used in research problems is essential in qualifying the final results. In the study of individual bees in their habits and behavior, it is necessary to have some means of identifying them. Accordingly when observations were begun on the behavior of worker bees in nectar, pollen and water gathering at the Iowa Agricultural Experiment Station in 1920, it was necessary to find a permanent means of marking bees as individuals. Working with Mr. O. W. Park, the Assistant in Apiculture, in 1921 the writer took up this problem.

In the past, investigators and beekeepers have used various materials for marking insects. Réaumur (15) in 1740 marked queens with red and yellow varnish which dried quickly. Huber (10) in 1790 painted queens to distinguish them, and in 1793 he powdered bees to observe them at work in the hive. Bonnet (4) in 1789 suggested to Huber that he use a varnish not affected by humidity to paint queens which he was studying. Bethe (2) in 1898 marked eight bees but does not state the material used nor how the work was done. Bonnier (5) in 1906 used talc which he colored and then dusted onto the bees. Kramer and Theiler (11) used a pigment in powder form with a quick drying alcoholic lacquer which was diluted with ether, it dried quickly and was permanent. Casteel (7) in 1912 used different colored paints and numbers to mark honey-bees for the study of wax manipulation. Brünnich (6) in 1914 used a glue of isinglass and color, the odor of which was detestible and it took several minutes to dry. He also used color mixed with lacquer which he applied with a needle. If too thick it did not remain on the queen. R. R. Parker (12) of Montana in 1916 marked flies in large numbers and not individually. His method was to use certain dyes which were sprayed onto the flies while in traps. To identify them necessitated killing the insects and then treating them chemically in order to bring out the colors of the dyes. Stokli (16) in 1919 soaked a pigment in alcohol to form a thick paste which was then diluted with ether to the right consistency. Queen (14) also in 1919 used any suitable non-corrosive pigment mixed

with white shellac which had been dissolved in alcohol. He used a small camel's hair brush to apply a spot on the thorax of queens. Bishop (3) in 1920 used powdered red and yellow chalk which remained for a few days on flies, particularly the halteres. Red was better than yellow in visibility. A mineral pigment was used but seemed deleterious to the insects. He also used double sprays as did R. R. Parker without much success. O. W. Park in 1920 used Sudan III in alcohol and fuchsin without success but did have some success with oil paints.

Since 1921 several others have published data on marking insects, particularly honeybees. Von Frisch (9) in 1923 used marked bees in behavior work. A mixture of powdered pigment, white shellac and alcohol of the consistency of a thick paste was used. He marked bees on the fore and rear part of the dorsal surface of the thorax as well as at the sides, the abdomen was also marked. Also in 1923 Dudley and Searles (8) used glue, colored chalks, aniline dyes, India inks, and commercial shellac without much success for marking cucumber beetles. Finally a mixture was evolved of dilute shellac with alcohol using alcohol-soluble shellac, colored with a saturated solution of the aniline dye in alcohol. This dried quickly, adhered well to the body, retained its color indefinitely, and did not interfere in any way with the normal functions of the insect. The solution was applied to the insects with an atomizer. "Bees marked with a solution of seven parts alcohol and three parts shellac dyed with aniline green, remained vividly colored for seven days after they had been marked." Alfonsus (1) in 1924 used lac, methyl alcohol and dry pigment with success for marking queens. Perret-Maisonneuve (13) also in 1924 used copal varnish, ethyl alcohol and dry pigment to mark queens. If the mixture became too thick it was diluted with ether to the correct consistency at the time of using. This mixture with ether, however, when by accident it came in contact with the antennae, disabled the queen.

A common method of marking the individuals of a hive by beekeepers is by dusting powdered chalk, flour or other finely divided material onto the bees. This is only temporary and is used to locate a disturbance or activity of some particular colony. Some clip the wings of their queens in such a way as to indicate their age.

Methods

Marking individual bees necessitates a method which is permanent and not deleterious to them in any way. The bees are to go about their work as usual after marking. They cannot be killed as in the case of the flies, because they are marked to find what they do as well as where,

when and how they go. To destroy or injure the insects would be to defeat the object for which marking is used in behavior study. The bees are free to go as they please, which being the case close observation is necessary and this requires high visibility, quick drying and non-injury.

The methods used in 1921 were brands, adhesives and pigments. Branding was done with a weak electric current heating a filament of "nichrome" wire as the branding instrument. The bees so treated were caught and either chloroformed or etherized before the burning was done. The use of anesthetics not being successful a wire holder was made to fit over the propodeum to hold the bee while it was being marked with the hot wire. Sealing-wax, melted by the branding apparatus was placed on the thorax and surrounding hairs. Both of these methods were discarded for one injured the bees and the other was not permanent.

Park had tried Sudan III and fuchsin in alcoholic solution the previous year, picric acid and safranin were now tried but all without success because they were hard to see. White lead in linseed oil was mixed with a pigment and ether was added, to hasten drying. Another combination tried was powdered pigment, linseed oil, ether, shellac and alcohol: this was simplified to powdered pigment, liquid shellac and ethyl alcohol, for the oil appeared to be superfluous and the ether affected the bees. The pigment, shellac and alcohol when mixed in the right proportion are quite satisfactory. This solution dries quickly, produces no after effects, and is without any disagreeable odor. The pigments used are non-corrosive and in the powdered dry state. An enamel was used with good success but did not dry as quickly as the shellac mixture, the bee being caged for a time until the enamel dried somewhat.

The mixture most nearly meeting the desirable points of permanence, visibility, quickness in drying and non-injury is that of one part pigment, one part shellac and one-fourth to one part ethyl alcohol. The bee while being marked is held by a small piece of wire bent to fit over the propodeum. The marking liquid is applied directly to the thorax or abdomen with a small camel's hair brush or tooth pick. Great care is necessary not to get any of the material on the wings, legs, or any part of the head, for this would incapacitate the bee, rendering it useless for work and observation. Bees marked by this method resume their work almost immediately. The best pigments from the standpoint of visibility are red (vermillion), chrome yellow, zinc white, cobalt or ultramarine blue, and a medium green. Certain combinations of these as orange, pink and purple may also be used. The permanence of the marking on worker bees is about two weeks, sometimes it wears off and at other times the bees can not be found, probably having died in the field.

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INFLUENCE OF TEMPERATURE AND HUMIDITY UPON THE VOLATILIZATION OF NICOTINE FROM TOBACCO DUST-LIME HYDRATE MIXTURES[1]

By LEON R. STREETER

ABSTRACT

A little water added to the tobacco dust-lime hydrate mixture insures the more rapid evolution of the nicotine, the moisture being more important than temperature.

During recent years, the use of tobacco dust and other nicotine-containing material as an insecticide has come into very common practice.

[1]Contribution from the N. Y. Agr. Expt. Station.

de Ong (1) of the California Agricultural Experiment Station, and Headlee and Rudolfs (2) of the New Jersey Agricultural Experiment Station have shown that the killing efficiency is directly proportional to the rate of nicotine evolution from nicotine-containing dusts and sprays.

Experiments conducted by MacLeod and Harman (3) with aphids enclosed in bell jars show that tobacco dust containing from 1% to 2% of nicotine, to which 25% of hydrate of lime was added, killed aphids by fumigation in one-half the time required to kill them by tobacco dust alone. Their trials were made with dry mixtures. In the light of recent investigations, it is clear that much greater differences in rate of killing would have been observed if sufficient moisture had been added to the combined nicotine dust-hydrate of lime mixtures to insure favorable conditions for the evolution of nicotine from these mixtures. They also show that tobacco containing from 2 to 5% of nicotine to which lime was added gave a high rate of killing when plants infested with aphids were dusted in the open air.

Huckett (4) working on Long Island with tobacco dust-lime mixtures, reports good control of the spinach aphis. This writer also reports that excessive moisture almost entirely destroys the killing efficiency of these mixtures.

In recent investigations Thatcher and Streeter (5) found that hydrate of calcium was effective in releasing nicotine from tobacco dust. They also observed that the addition of limited amounts of water to dry dusts increased the rate of evolution of nicotine from them, whenever this evolution was due to a chemical reaction between the nicotine-containing material and the carrier used.

Most of the nicotine in tobacco is held in combination with organic acids which render it practically non-volatile under normal conditions of temperature and humidity. According to Garner (6), there is a gradual loss of nicotine from tobacco during the curing process, as a small part of the nicotine is loosely held in combination. This loss, however, is too slow to be effective in killing insects by fumigation.

In view of the work previously reported, the following experiments were planned to determine some of the factors involved and to ascertain under what conditions tobacco-lime mixtures liberate nicotine effectively.

The tobacco used contained 4.45% nicotine and 6% moisture. The tobacco dust was mixed with equal parts by weight of pure calcium hydrate. Both these materials were passed thru a 150-mesh sieve before mixing.

Twenty grams of the mixed material constituted a sample, which was spread out in as uniform a layer as possible over a definite surface area of

8" x 6". The different samples so arranged on trays were then placed in a constant-temperature humidity chamber, the so-called "Carrier Processing Cabinet." At the end of 24 hours the entire samples were taken up and intimately mixed for nicotine analysis. The temperature range used in different trials varied from 70° F. to 100° F., with the relative humidity varying from 50% to 70%.

The results reported in Table 1 represent analyses of closely agreeing duplicate and, in many cases, of triplicate experiments.

TABLE 1.—PERCENTAGE OF THE NICOTINE EVOLVED IN 24 HOURS FROM TOBACCO-LIME MIXTURES CONTAINING APPROXIMATELY 2.15% NICOTINE

Temperature F.	Relative Humidity		
	50%	60%	70%
70°	—	7.4	39.3
80°	—	23.4	62.0
90°	9.8	42.2	74.3
100°	25.5	63.0	84.1

It is apparent from the above results that the nicotine evolved from such mixtures increases gradually with increases in temperature; likewise, with increases in moisture, at least up to a relative humidity of 70%. These data also show that sufficient moisture is more essential to this reaction than a high temperature, a temperature of 70° F. with a relative humidity of 70% being a more favorable condition for the release of nicotine than a temperature of 90° F. with a relative humidity 50%. A temperature of 80° F. with a relative humidity of 70% is nearly equivalent to a temperature of 100° F., with a relative humidity of 60%. Tobacco dust subjected to the same conditions showed no appreciable loss of nicotine. In consideration of these facts, it appears that it will be practical to add a small quantity of water to the tobacco dust-lime mixture just before it is applied in the orchard or garden, to ensure more rapid evolution of the nicotine. Provided sufficient moisture is not present to permit the chemical change, lime-hydrate acts as a diluent of the tobacco dust. If a diluent is desirable for tobacco dust of high nicotine content, lime-hydrate may be used for this purpose, or enough lime to convert the combined nicotine into a volatile form, together with some inert dust material of superior physical properties.

If killing efficiency is dependent upon volatile nicotine, then such mixtures should necessarily be more effective than tobacco dust alone.

(NOTE: Since the above was written, the writer has learned that unpublished results of investigation at Pennsylvania State College fully confirm this supposition, in that field experiments with mixtures of

tobacco dust with hydrated lime gave a killing efficiency directly in proportion to the amount of water added to the dust mixtures just before using up to the quantity of water which is more than sufficient for the necessary chemical reaction. Beyond that proportion, added water was found to result in decreased efficiency due to its power of dissolving the liberated nicotine and also because it rendered the dusts too damp for satisfactory spreading.)

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OBSERVATIONS ON INSECTS DEVELOPING IMMUNITY TO INSECTICIDES

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The development of increased immunity to hydrocyanic acid gas by the red scale and black scale in certain districts of California, which have in the past relied upon fumigation for control, has become so pronounced that a single treatment even at a greatly increased dosage no longer can be depended upon to keep these pests in control. Double fumigation is often unsatisfactory and very expensive. A situation has arisen, the solution of which demands the introduction of new methods and materials. A wave of spraying, in some cases combined with fumigation, has been sweeping these districts. At present a very unsatisfactory condition exists.

Sprays, fumigants and poisons in general are the most widely used means of the economic entomologist in protecting plants from insect pests. The basic insecticides largely depended upon in pest control include arsenicals, lime sulfur, tobacco, cyanid, carbon bisulphid, soaps and oils. If long continued use would tend to develop immunity of pests to insecticides the field of pest control would become even more complex than at present. For instance, how disturbing would be immunity to

arsenicals developing in such major pests as the codling moth or cotton boll weevil!

In 1914 Melander[1] in discussing the question whether insects might become resistant to sprays presented data to show the greater susceptibility of the San Jose scale to lime sulfur in some localities than in others, and suggested the possible development of resistant strains due to repeated applications. Quayle[2] has more recently called attention to the greater resistance of the California red scale (*Chrysomphalus aurantii* Maskell) and the black scale (*Saissetia oleae* Bernard) to fumigation with hydrocyanic acid in some districts than others in southern California.

The present paper supports the observations of Quayle that these two pests are developing greater resistance to fumigation, and shows that the area of resistant scale is spreading. This situation is upsetting the long established fumigation practice in California and encouraging the widespread introduction of sprays.

Red Scale

The first observations on red scale developing increased resistance to fumigation were made in the Corona district during 1914. Commercial fumigators previously successful in fighting the pest with hydrocyanic acid gas at a moderate concentration commenced to experience difficulty of control even with greatly increased dosages. The margin of safety which previously had existed between the dosage which the tree could withstand without injury and that required to destroy red scale now became practically eliminated and the gas concentration was increased to what trees would stand during their most inactive period. This situation later lead to a shifting of the fumigation season for red scale to the winter and spring months.

Shortly following the Corona experience a second infestation of resistant scale appeared in a nearby district. The area of this so-called resistant red scale has gradually enlarged until at the present time its range includes a foothill area in Orange and Los Angeles Counties 25 to 30 miles in extent, adjoining the original Corona infestation which also is now widely extended.

The question might properly be asked, "How do you know the red scale in the aforementioned area is developing immunity to hydrocyanic acid gas?" It is by observation and experiments covering the period

[1]Jl. Econ. Ent., Vol. 7, Page 167,—ibid, Vol. 8, Page 475.
[2]California Citrograph, Vol. 4, Page 260, 1919. Jl. Econ. Ent., Vol. 15, Page 400, 1922.

since 1907 which antedates this resistance tendency. From 1907–09 the writer conducted experimental work for the Federal Bureau of Entomology against red scale throughout the area now considered resistant. A wide range of gas concentrations were used in these experiments. It was found from this work that the red scale was readily controlled in any district by a fumigation dosage designated as a ¾ or 75 per cent dosage schedule.[3] The experimental work was corroborated by extensive checks on commercial operations and a 75 per cent schedule became the standard for red scale control everywhere.

In 1918, experimental fumigation was again undertaken against the red scale and many checks have been made between then and the present time. This latter work has included tests in the same localities, sometimes in the same orchards used in 1907–09. Whereas the early work thoroughly controlled, sometimes eradicated the red scale with a 75 per cent dosage, our latest experience has been that in many cases a dosage as high as 150 per cent or twice that formerly used has not proven entirely satisfactory in the resistant area. Some lemon orchards treated with these excessive dosages have needed and received a second fumigation during the same year. The writer knows of one orchard fumigated twice during 1923 with a 120–140 per cent dosage schedule and was still in need of a third application. There is a limit to the cost of pest control in profitable citrus production. Control of red scale by fumigation in the more resistant areas is very unsatisfactory, perhaps in a worse condition on lemons than on oranges. In fact, the red scale appears far more difficult to control on lemons than on oranges even in the same orchards. Spraying for this pest has up to the present been largely a failure.

Some districts experience little difficulty in handling the red scale by fumigation; in fact, this scale is controlled almost as easily today over a large part of the citrus belt as it was 15 years ago. In order to bring out the comparative resistance of this scale in the non-resistant districts with that in the area where difficulty of control is experienced the writer during 1924 performed a series of experiments in which freshly picked red scale infested fruit from eight different localities were fumigated simultaneously under the same tent. Three gas concentrations were used in each experiment. The exposure was 45 minutes.

These experiments confirmed field experience as to which localities have the most resistant scale. The ordinary commercial dosage for red scale at Altadena and San Dimas is 85 to 100 per cent. In the other

[3]Author's dosage schedule on which citrus tree fumigation in California since 1909. has been based.

	Experiment 1			Experiment 2		
	Dosage			Dosage		
	100%	125%	150%	85%	125%	150%
Altadena	2 alive*	0 alive	0 alive	2 alive	0 alive	– alive
San Dimas	2 "	– "	– "	10 "	0 "	– "
Corona	6 "	1 "	0 "	19 "	2 "	0 "
La Habra	24 "	5 "	0 "	15 "	– "	0 "
Yorba Linda	7 "	1 "	0 "	30 "	3 "	2 "
Arlington	5 "	2 "	1 "	53 "	1 "	1 "
Orange	13 "	3 "	1 "	27 "	4 "	2 "
E. Whittier	16 "	5 "	2 "	25 "	1 "	1 "

*Insects alive per 1,000 dead, 90 lemons representing each locality in both experiments.

localities it varies from 100 to 150 per cent and even then frequently with unsatisfactory results. In these experiments the scale at Altadena and San Dimas was eradicated at a dosage of 125 per cent wherein living scale could be found at this dosage for all the other localities. Scale survived 150 per cent dosage from 4 of those most resistant.

Black Scale

The writer's experimental results for 1907–09 showed that the black scale in its immature stages was effectively destroyed throughout southern California with a 75 per cent dosage schedule. In 1912 his attention was called to a few orchards in the Charter Oak district where fumigation was somewhat unsatisfactory against this pest. Experimental work at the time on a 10 acre orchard showed the scale was not fully controlled by a 75 per cent schedule. Resistance to cyanid gas by this scale became more noticeable in this district in the succeeding years—the area of unsatisfactory control spread. Nearby districts were first affected. Today, 12 years after its appearance was noted, this resistant type of black scale is to be found over an interior district fully 35 miles in extent devoted largely to orange production. Fumigation dosages of 100 to 120 per cent can not be depended upon to give control for a single year where formerly a 75 per cent dosage usually gave control for two years. There appears to be a decided variation in susceptibility to cyanid gas between different localities and even orchards within this so-called resistant black scale area. Such districts as Valencia Heights near Covina and Sierra Madre are less resistant as a whole than Charter Oak or Claremont. There appears to be little or no difference in susceptibility between this scale on lemons and oranges. Lemons, however, are more readily cleaned than oranges as they will endure with safety a much higher dosage than the latter.

The black scale situation over the resistant area has become most discouraging to producers. It has developed to be the most important problem affecting production. A single fumigation can no longer be

depended upon to control and repeated fumigation is prohibitive in cost. Growers are rapidly turning to spraying. The California Fruit Growers Exchange has been investigating this problem for the past year and their results indicate a combination spray and fumigation, or double spray program might offer a satisfactory solution.

A Confusing Situation

The resistant black scale is confined to the interior citrus district eastward from Los Angeles for 35–40 miles. Over this same area the red scale is readily controlled by fumigation with ordinary dosages. The area of resistant red scale is separated from the resistant black scale district by a chain of hills. Black scale is common throughout this red scale area, perhaps even more numerous as a whole than the red scale, yet it is readily controlled by fumigation with a moderate dosage. What is the explanation for this condition? If immunity to hydrocyanic acid gas is the result of repeated fumigation why should not this trend toward immunity develop simultaneous for both species over the same area? The writer is inclined toward the belief that these resistant strains of scale are not springing up independently in different orchards. Rather, that the resistant red originated at Corona and the resistant black at Charter Oak; that the scale over the present resistant areas are outgrowths from the spread of these two strains. Support to this contention is given by the fact that from the beginning spread has been more or less progressive outward from these two centers. The latest areas to show resistant tendencies are most distant from Corona and Charter Oak.

A NEW PARASITE OF THE ALFALFA WEEVIL[1]

By T. R. Chamberlin, *Assistant Entomologist, U. S. D. A.*

Abstract

The following article relates features in the life-history of the eulophid parasite *Tetrastichus incertus* (Ratz) as disclosed by the study of alfalfa weevil material from various parts of Europe. A brief account of the previous history of the insect is included together with its known distribution and attention is directed to its probable usefulness as a parasite of the alfalfa weevil in the United States, providing establishment should prove successful.

During June, July and August 1922, while the writer was located at Hyères, Var, France, opportunity was afforded for the study of some alfalfa weevil material collected as larvae from fields in Italy near Bevagna, Poggiomarino, Acerra and Piedimonte d'Alife. Larvae from the

[1] *Phytonomus posticus (Gyll.)*

last two towns proved to be heavily parasitized by a species of eulophid which has been determined by A. B. Gahan as *Tetrastichus incertus* (Ratz.). W. R. Thompson recognized the species as that which he had reared in small numbers from larvae collected in Switzerland in 1912 and 1913, and an examination of some preserved material at the Salt Lake Laboratory shows that P. H. Timberlake, while engaged in parasite liberation work in 1913 encountered the same parasite in small numbers in imported material. Thompson thought that the insect was a primary while Timberlake suspected that it was a secondary parasite. The study of material collected in the field, together with the breeding work conducted by the writer at Hyères, indicates that the insect is a most promising primary parasite upon *Phytonomus posticus* (Gyll.) but its various possibilities as a secondary parasite on other hosts have not been determined.

Previous History of the Parasite. *Tetrastichus incertus* was first described by Ratzeburg in "Ichneumonen der Forstinsecten," Vol. 1, 1844, p. 168 under the name of *Eulophus incertus*. No host records or localities are given. The species has been mentioned in literature only once since the original description and this reference is by Nicholas Kurdumov in "Rev. Russ Ent.," Vol. XIII, 1913, No. 2, p. 254. Kurdumov merely gave a more complete description and mentioned no hosts nor localities.

Known Distribution of the Parasite. The study of material preserved at the Salt Lake Laboratory and the work at Hyères have enabled the writer to furnish the following list of localities in which the parasite has been found.

Switzerland
- Sarn, Grissons
- Adliswil, Zurich
- Rümlang, Zurich

France
- Montmélian, Savoy

Italy
- Acerra, Campania
- Piedimonte d'Alife, Campania

Germany
- Halberstadt, Prussian Saxony
- Ballenstadt, Anhalt
- Gernrode, Anhalt
- Blankenburg, Anhalt
- Bärwalde, Brandenburg

The insect has appeared to be rare in all these places except in Acerra and Piedimonte d'Alife in 1922.

Shipment and Manipulation of Material. The host larvae from Italy studied in 1922 were shipped by mail to the laboratory of the U. S. Bureau of Entomology at Hyères in 2″ x 3″ x 8″ boxes of soft, absorbent

wood, and were well supplied with alfalfa as food while in transit. The alfalfa was kept from lodging and becoming unduly mouldy by bits of branching twigs. In general, the larvae arrived in very good condition, but a large number of them were reddish brown in color and dead. Dissection of the latter showed them to be invariably infested with chalcidoid larvae or pupae. Host larvae and prepupae known to be parasitized, as indicated by their reddish brown color, the feeding larvae, and prepupae and pupae in which parasitism was not apparent were usually separated at once. The feeding larvae were supplied with fresh alfalfa until they were either killed by parasites or had spun cocoons, while the prepupae and pupae which did not appear parasitized were kept for future evidence of parasitism. The total that arrived in the boxes and the total that ultimately proved to be parasitized furnished the figures used in calculating the percentages which follow.

Extent of Parasitism. A total of 36 boxes containing parasitized larvae were received, 9 from Acerra and 27 from Piedimonte d'Alife. They contained from 46 to 493 larvae each, totaling 6647 and averaging 184.4 per box. Of the total, 4737 or 71.2% were parasitized by *Tetrastichus incertus*. The parasitism per box varied from 54.6% to 85.8% with one exception in which it dropped to 27.7%. From the 6647 larvae, a relatively small number of *Bathyplectes curculionis* (Thoms.) and nematodes were also reared.

Stages of the Host Parasitized. Parasites were found in the larvae and prepupae of the host but never in the pupae. When found in the prepupae, in a great many cases, they were known to have come from eggs laid in the larvae and it seems probable that this is the usual method of oviposition. Larvae in which parasitism is well advanced when the time for spinning arrives do not spin, but those in which parasitism has been effected shortly previous to spinning time, spin at about the proper time and in about the normal fashion. Parasitism of the pupae has never been effected in breeding experiments in the laboratory.

Number of Parasites per Host. Dissection of 16 parasitized weevil larvae disclosed from 6 to 17 parasites each and an average of 10.7 per host. The average issuance per host from three lots of 10 parasitized larvae each was 14.7, 12.0 and 10.3.

Appearance of Parasitized Larvae. The first external evidence of parasitism by *Tetrastichus incertus* is a slight yellowing of the host, but since similar changes are produced by other parasites, infestation by this particular species is not always apparent at this stage. Gradually the yellow color deepens and then changes to pink. Often while the yellow

color still predominates, the feeding larvae can be seen through the skin of the host, but this is not always possible until the color has become pinkish. From pink, the color rapidly changes to deep reddish brown, often within twelve or fourteen hours. The reddish brown larva is then a mere skin the interior of which has been devoured by the parasites and which has become owing, probably, to secretions of the parasites themselves, a more or less impermeable, brittle capsule which serves as a pupal case for the parasites. The larval skin at this stage is plump and distended except at each end where the walls have collapsed and become cemented together. If the skin contains many parasites, the distended portion is long and the sealed terminal portions short while if there are but few parasites, the distended portion is shorter and the sealed portions longer.

REPRODUCTION OF *Tetrastichus incertus* (RATZ.) In laboratory experiments, the parasite reproduced freely upon healthy and unparasitized larvae of *Phytonomus posticus*. In 1922, experiments were conducted upon larvae collected from the fields in regions in which *Tetrastichus incertus* was not being found and in 1923, upon larvae hatched in the laboratory.

In each of the 1922 experiments, the female mounted promptly upon the back of the host, usually inserting her ovipositor in the posterior third of the body. She remained in this position from 3 to 10 minutes, frequently working her ovipositor up and down. The larva did not seem to be especially annoyed at any time. From 17 *Phytonomus* larvae confined with 6 females of the tetrastichine, a total of 40 living adult parasites and 51 parasitic larvae were secured. The average time for development of the parasite from egg to adult was not obtained because in order to make sure that parasitism would be effected, the parasites were confined with the larvae for several days and the exact time of the various ovipositions was not learned. In one case, the weevil larva was dead and reddish brown in color 10 days after the parasite was first confined with it and adult parasites issued about 1 week later.

In 1923, in addition to breeding the parasite upon larvae known with absolute certainty to be free from other parasites, several attempts were made to breed it as a secondary parasite upon *Bathyplectes curculionis* (Thoms.), the most common primary parasite upon *Phytonomus* larvae in Europe, and also to breed this *Bathyplectes* as a secondary parasite upon *Tetrastichus incertus*. Both of the latter tests were made upon weevil larvae hatched in the laboratory which the writer parasitized or attempted to parasitize, with both of these species. In no case did either

species reproduce as a secondary parasite. This fact, of course, does not prove that such reproduction never occurs in nature but it would indicate that it is not the normal or common method.

No eggs of *Tetrastichus incertus* were dissected from its host and none were seen in the process of development, so that it is not known whether the reproduction is polyembryonic or the parasite places an egg in the host for each parasite which develops.

Many parasites received in late summer failed to issue from their host until the following spring and it seems probable that the insect passes the winter in the field in this way.

OTHER HOSTS OF *Tetrastichus incertus* (RATZ.). *Tetrastichus incertus* was not encountered in connection with any other host collected in the field and nothing was learned of other possible hosts of the species. The writer bred the insect in the laboratory in larvae of *Hypera punctata* (Fab.) but the adults which developed failed to issue, presumably because they were unable to cut through the heavy integument.

PARASITES OF *Tetrastichus incertus* (RATZ.). No insect suspected of being parasitic upon *Tetrastichus incertus* was found associated with it when present in hosts collected from the field as larvae, but when present in hosts collected as prepupae, a species determined by A. B. Gahan as *Eupelmus atropurpureus* Dalm., was found to para itize a small percentage of them. No more than one *Eupelmus* issued from a single *Phytonomus* prepupa but all the primary parasites were destroyed. It appears, therefore, that this secondary parasite is a predator upon *Tetrastichus* although always concealed within the skin of the weevil prepupa. This parasite was bred upon *Tetrastichus incertus* in the laboratory when it was shown that the parasite makes use of the weevil cocoon as a support during oviposition. The need of such support probably accounts for the failure of the species to parasitize *Tetrastichus* in unspun stages of the weevil.

SUMMARY AND CONCLUSIONS. A eulophid parasite has been found to exist over a rather wide range of territory in Europe and at times to parasitize a high percentage of the larvae of *Phytonomus posticus* (Gyll.). It was proven by examination of field material and by reproduction experiments in the laboratory to be normally a primary parasite of the weevil and the indications are that it is rarely if ever secondary upon any of the known parasites of the weevil. It is found in the high mountain valleys of Switzerland, in France near Switzerland, along the foothills of Italy near Naples, and in the plain regions of Brandenburg and Anhalt in Germany. Although the insect has usually appeared to be scarce, its distribution

together with the high rate of parasitism it sometimes attains would indicate that it may thrive and become an important parasite if established in the weevil infested territory of the United States. On account of the large number of parasites per host and their small size, it would be difficult to liberate them safely from large miscellaneous collections of weevil material, but since it is easy to breed in the laboratory, exportation from laboratory bred material or liberation of parasites bred from small importations should not prove difficult.

OBSERVATIONS ON THE CUTWORM, *EUXOA AUXILIARIS* GROTE, AND ITS PRINCIPAL PARASITES

By STERLING J. SNOW, *Assistant Entomologist, Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACT

This paper is an account of an outbreak of the cutworm, *Euxoa auxiliaris* Grote, on alfalfa at Vernal, Utah, in 1916, which seemed, but was not conclusively proven, to be controlled by parasites, of which about a dozen species were reared as follows: *Berecyntus bakeri* Howard, *Apanteles laeviceps* Ashmead, *Meteorus vulgaris* Cresson, *Amblyteles nuncius* Cresson, *Habrobracon erucarum* Cushman, *Paranomalon* sp., *Ernestia* sp., *Anthrax alternata* Say, *Anthrax willistonii* Coquillet, *Aphiochaeta* sp., and *Phorichaeta cinerosa* Coquillet. It contains some data on the life history, habits and occurrence of both the host and its principal parasties as observed in the field and while rearing them in an improvised insectary.

This paper is a report of field and laboratory observations made in 1916 upon the cutworm, *Euxoa auxiliaris* Grote, attacking alfalfa at Vernal, Utah. A serious outbreak occurred there in 1915 and on reports of injury in 1916, the writer was detailed to make an investigation but found only a few fields damaged and these so slightly as not to require remedial treatment. Enough cutworms were present to permit biological studies and accordingly field observations and rearings of both the cutworms and their parasites were carried on from the first of May to the middle of June, after which examination of the material was continued at Salt Lake City. Observations were made throughout this period in irrigated and unirrigated areas of the infested fields to determine the number of larvae present at different times, diseased larvae on the surface, larvae in cells, pupae, and natural enemies, as well as to note the condition of the alfalfa, soil, and the activities of the cutworms. Many square yards were dug up during this period, yielding about five or six larvae or other form of the insect to the square yard.

Fourteen hundred seventy-eight larvae were reared in cages to obtain adults, parasites, and data on life history and parasitism. They were

collected in the field on various days from May 3rd to June 5th and placed in a variety of cages including large pasteboard boxes, glass dishes, tin boxes, and tobacco cans, in which was placed a mixture of sand and loam, slightly dampened. In some cases the soil on drying was replaced by fresh moist soil. Parasite cocoons and adults were put in vials with cotton stoppers. For protection from animals and to guard against the escape of any of the specimens, all of these cages were kept in a tight wooden cage, 3 x 5 x 3½ ft. lined with a veneered panelling, roofed with tin, and provided with a tight fitting door. This cage stood in the sun except in the early morning. Alfalfa clippings were supplied for the first few days to furnish food and moisture. The surface of the soil in these cages and the sides of the cages were examined nearly every day and the parasitized and diseased larvae and all apparently parasitized larvae were segregated. This process increased the number of cages to such an extent that it was impossible to examine them all thoroughly every day. Moreover it was considered best not to make a thorough examination frequently since any disturbance of the soil caused larvae which were building cells to abandon or delay finishing them, and larvae which had finished cells seldom built others if the first were broken into. In a few cases the soil in the small cages was examined thoroughly only at the end of the experiment. This made inexact the dates of some of the changes which took place.

There were usually several larvae kept in each cage and in two of the larger boxes as many as 100 were confined.

The tin boxes and tobacco cans with tight-fitting lids kept the soil moist and proved to be best for rearing purposes.

Humidity was generally moderate, with occasional frosts, but no rains in May or June. About $\frac{1}{16}$ of those placed in the cages matured, and about $\frac{1}{8}$ died of causes other than disease such as confinement and injury in handling. It was estimated that $\frac{5}{16}$ were killed by parasites, and nearly $\frac{1}{4}$ by disease. The remaining $\frac{1}{4}$ presumably were eaten by the others. Seventy-six of the fatalities occurred after the building of the earthen cells. About $\frac{3}{4}$ of these were pupae, which, upon dissection, were found to be nearly adult. All except two of the moths proved to be *Euxoa auxiliaris*.

Seasonal History

The cutworm larvae were found to be ½″ to 2″ long, the majority being 1 to 1½″ long in early May. It is assumed, therefore, that some of them must have been ½ to ¾″ long in the fall of 1915 just before winter set in. Others were probably much smaller and some eggs may

have hatched in the spring since larvae ½" long were found as late as June.

The active free larva was the most numerous form present in the fields during May and early June. Most of the larvae were approaching full size by May 1st, and soon thereafter began disappearing beneath the surface where they remained a few days without feeding before building their earthen cells, a process which occupied about one day. The first cell was found in the field May 6th. They were found in increasing numbers, especially after May 15th, until the end of the month. Of 50 larvae placed in separate tin boxes with soil on May 3rd and 4th, 32 constructed cells within a few days of May 20th, the mean date. Six transformed to moths without building cells. During late May and early June, the larvae in cells were the next most numerous form of the insect present in the fields.

During the several days which passed between the completion of the cell and the beginning of pupation, the larva shrank to about one-half its former size, so that it lay extended in the cell instead of being curled up as at first. It also became smaller posteriorly, lighter-colored ventrally, and slightly sluggish. The average length of this interval, with larvae kept in cages, was 10 days. The first pupa was found May 16th, but pupae were the least numerous form until June 1st. Those kept in cages had an average pupal period of 32 days. The last pupa was formed in the cages on July 2nd. The first moth of the reared specimens emerged June 17th, and the last one about July 19th.

Feeding

During the middle of the day the larvae usually lay sluggishly in the open loose soil between the plants, not in or near the crowns. They were found from one-half inch to two inches, usually about one inch, below the surface. A few larvae seen above ground were seen to eat only on cloudy days, and were either sluggish or unusually active. Some of the sluggish ones were found later to be diseased or parasitized, and the active ones always disappeared under the plants or debris after crawling fast for a few feet usually in a straight line. Toward evening the larvae began to appear above the surface, and after sundown their numbers increased, particularly those of the small and medium sized larvae.

The feeding of the species consisted of nibbling at the edges of leaves, branches and stems, and rarely resulted in cutting off the stem in the traditional cutworm style. Occasionally plants were found with the leaves and branches completely stripped from the stalks. In 1915 when

the infestation was severe, the plants were eaten down to and below the surface of the ground.

Spinning

After resting an inch or two below the surface of the ground for several days, the full grown larvae usually went deeper and built their cells one-half inch to two inches below the surface of the hard subsoil, usually about three inches from the top of the ground. The cells were roughly oval, from ⅔ to 1¼ inches long and ¼ to ½ inch in diameter, and, with few exceptions, stood on end with the head upward. Those which were made inside the rearing cages were fastened horizontally to the bottom of the box. The wall was about 1 mm. thick, compact and hard, composed of fine particles smoothly cemented together on the inner surface, and often with larger particles adhering to the outside making the shape irregular. The cell wall was not impervious to water. Several larvae which were observed making or repairing their cells exuded a liquid from their mouths as they picked up or arranged the grains of dirt which appeared dark when wet with this liquid. Newly completed cells, although in contact with dry dirt, were still soft and damp throughout indicating that the process of building the cells was of short duration. None was observed to build the cell a second time when disturbed after the contraction stage or prepupal period had begun.

Disease

In the field many cutworms were found dead above the surface of the ground and a few beneath, and nearly all of these were dark and flabby indicating that they had been killed by disease. Except for one pupa, these were all large larvae and nearly all without cells. Of the 1478 larvae kept in cages, 460 were found dead at or near the surface of the soil, and nearly 400 of these had the appearance of being diseased. They appeared to have died at about the same rate during May and June. The first symptom of the disease to be noticed was sluggishness, and, in many cases, a bloated condition. Soon thereafter the tissues broke down rapidly, becoming black, flabby, and ill smelling, and finally exuding through the broken skin.

Parasites

Four hundred forty cutworms out of the 1478 placed in cages were killed by parasites as follows: *Berecyntus bakeri* Howard 214, *Apanteles laeviceps* Ashmead 77, *Meteorus vulgaris* Cresson 26, *Amblyteles nuncius* Cresson 13, *Habrobracon erucarum* Cushman 1, *Paranomalon* sp. (probably) 1, *Ernestia* sp, 74, *Anthrax alternata* Say and *Anthrax willistonii*

Coquillett, 9, *Apiochaeta* sp. 3, *Phorichaeta cinerosa* Coquillett (probably) 20,[1] and 3 were killed by a digger wasp.

HYMENOPTERA

Berecyntus bakeri Howard (Encyrtidae)

The presence of *Berecyntus bakeri* was first detected in full grown cutworms 86% of which had made pupal cells. These cutworms were so distended, because of the thousand and more parasitic larvae, each about 1 mm. long, growing within them—1068 and 1511, respectively, were reared from two of them—that they completely filled the earthen cells in which, instead of lying extended as do normal prepupae, they were folded upon themselves. They died soon after the appearance of the Berecyntus larvae, on May 17, most of them during the following three weeks. The first parasites pupated June 9th, in cells, usually lengthwise of their host, except as the folded condition of the cutworm in the cell disturbed this arrangement. The adult stage was reached June 26th and during the next month. The adults from the same host were of the same size and sex and issued at about the same time, leaving the host a shell of light crumbly skin and tissue, dry and perforated like a sieve. Nearly all of the Berecyntus adults issued from every one of the 214 host worms except 7 which were diseased. They lived several days without feeding, and those from the same host died at about the same time.

Apanteles laeviceps Ashmead (Braconidae)

The first symptom of parasitism by this species was unusual activity of the cutworms when they became about an inch long. Unlike others they crawled on the surface of the soil and on the walls of the cages in the daytime, swinging their heads around just previous to the issuance of the parasite larvae and quieting down after these larvae began to issue from their backs and sides. Sometimes they remained quiet after the issuance and died soon after, covered with Apanteles cocoons, but more often they crawled a short distance away, carrying one or two half-issued parasite larvae with them. They usually lived from a few hours to one or two days after the parasites had emerged, remaining on the surface of the ground and not eating. One lived four days.

The Apanteles larvae spun up immediately upon emerging, attaching themselves to the host, to the ground or to each other, usually the latter. Seventy-seven clusters of the cocoons, usually of 15 to 40 each, and totaling 1799, were found between May 18th and June 13th. The time spent within the cocoon varied from one to three days in the same cluster,

[1]This count is an estimate.

and in eight clusters reared separately was 7 to 14 days, averaging 10 days. Practically all the parasites reached the adult stage. They issued from May 26th to June 24th, and lived a week or more, frequently feeding and mating.

Several attempts were made to breed Apanteles; forty-two cutworms were exposed, one at a time, for a few minutes to a few hours. In every case the parasites stung the cutworm repeatedly regardless of whether it had been attacked by others. Some would insert the ovipositor instantly and dart away. Others would retain the ovipositor for several seconds while being dragged about and snapped at by the cutworm. In two cases Apanteles adults were reared from these exposed cutworms, after 24 and 27 days respectively, but the latter may already have been parasitized when collected.

Meteorus vulgaris Cresson (Braconidae)

Cutworms attacked by this species were seldom noticed until after the parasites had emerged and spun cocoons, leaving, in most cases, only the head of the host. As 88% of the cutworms parasitized by Meteorus had built earthen cells, the cocoons of the parasite were found clustered inside them. Where the host had not made a cell the cluster was found on the surface of the soil or sometimes below the surface, often with a few cocoons scattered several inches apart from the others, by the crawling of the host after the parasites had begun to emerge, but still attached by a single silken thread. Four hundred forty-two cocoons were found, a cluster to each of 26 cutworms, between May 4 and June 21. The emergence of adults took place between May 15 and July 8, five clusters kept separately having an average cocoon stage of 12 days.

Habrobracon erucarum Cushman (Braconidae)

A single cutworm was killed by *Habrobracon erucarum*. Fifteen larvae of this parasite emerged from a full-grown cutworm on May 16 and immediately spun cocoons from which 13 adults issued from June 7 to 12. The white, parchment-like cocoons were not arranged in a cluster. The adults lived several days, frequently mating and ovipositing in cutworms, 14 of which were exposed to them, usually one at a time, for 24 hours and then removed to separate tin boxes containing soil, but all died within a few days.

Amblyteles nuncius Cresson (Ichneumonidae)

No change was observed in the appearance of larvae or pupae parasitized by *Amblyteles nuncius*. Nine adults of this species issued from cutworm pupae, one to each host, from June 12 to July 3 and 4 were

found dead within shrunken host pupae. They lived only a few days and failed to oviposit in cutworms presented to them.

Paranomalon sp. (Ichneumonidae)

A single Paranomalon, almost adult, was found within a cutworm pupa on Nov. 2. Through a hole in the host it could be seen to move when disturbed and remained alive until Dec. 9 without issuing from its pupal case.

DIPTERA

Ernestia sp. (Tachinidae)

One-sixth of all the cutworms parasitized were killed by Ernestia sp. Five parasites were found in the larval stage, one of them near a cutworm, two within cutworms, and two within pupae; and 69 in puparia, of which 10 were found outside host larvae, 6 within earthen cells and 10 within host pupae, while the remaining 43 were for the most part found near dead cutworms The host reached full size and in one-half the cases built a cell, but died and became soft and flabby by the time the parasitic larva had become full-grown. In issuing, the parasite larva, one to each host, ate a hole in the side of the latter and left it a nearly empty skin, but when the issuance took place within an earthen cell the skin also was devoured. The first parasite larva was found May 4, 1915 and the first adult to issue, April 2, 1916.

Anthrax alternata Say (Bombiliidae)

Anthrax willistonii Coq.

Eight Bombylids, 6 belonging to the species *Anthrax alternata* and 2 to the species *A. willistonii*, were reared from cutworm pupae August 7 to 25; and 4 dead adults, imperfectly formed, were found by dissection in slightly shrunken Euxoa pupae.

The first abdominal segment of the pupa is armed with a row, interrupted on the median dorsal line, of stiff, recurved bristles, 2 mm. long, which are used in issuing from the pupa of the host and moving over the soil. In this process, the thorax and abdomen are contracted at their junction so as to turn the bristles forward against the former; then the body is straightened, moving the bristles backward until they lie against the abdomen, and this movement sends the pupa forward and out of the host. Each abdominal segment has a row of short, stiff, curved bristles and three pairs of larger spines which probably assist in the movement. One parasite was seen to propel the pupa of its host upward in the soil until the head of the latter projected above the surface. It then slit a hole in this pupal case and within a minute wriggled out. A few minutes

later it slit its own pupal case, emerged and immediately spread its wings.

Aphiochaeta sp. (Phoridae)

Larvae of *Aphiochaeta sp.*, 1 mm. long, slender and dull white, were first seen actively moving around in one cutworm on June 5 and in another on June 12. Fifteen adults issued from the latter June 25.

Phorichaeta cinerosa Coq. (Tachinidae)

Twenty reddish cocoons nearly 5 mm. long were found in the soil of the cages, some of them near dead cutworms, between May 16 and June 13. Eight adults issued from these cocoons June 12 to 24 and were determined as *Phorichaeta cinerosa*.

———— (A Digger wasp)

Three dead cutworms were found June 3 about 2 inches below the surface of the soil, each with its body contents half eaten away by a yellowish-white larva, 15 mm. long, which was half within and tenaciously attached to it. One of these predacious larvae constructed on June 8 a large, oval, transparent cocoon, which later became brown and woolly. The adult issued July 10 as a large black digger-wasp.

Conclusion

The presence of so many parasitic species and the abundance of certain ones were probably important factors in preventing a recurrence of the serious attack of 1915, and while the careful investigation here summarized failed to show conclusive evidence of actual control by them, the fragmentary life-history observations presented may prove useful in the study of future cases of apparent parasitic control.

PARASITISM OF THE STRAWBERRY LEAF-ROLLER *ANCYLIS COMPTANA* FROHL.

By Harold C. Lewis, *Ohio State University*

Abstract

In the accounts of the outbreaks of the strawberry leaf-roller, *Ancylis comptana* Frohl., which are more or less sudden and local, at no time have parasites been mentioned as common. In a study of the parasites of the leaf-roller under normal infestations, six species of Hymenopterous parasites, three more probable parasites, and one Tachinid fly were found to be parasitizing the leaf-roller. Four additional species are reported in the literature, which were not obtained in this study. Observations would indicate that at least during the season of 1924 in Ohio, the natural enemies maintained a sufficient check on the leaf-roller to prevent serious injury.

In the various accounts of the strawberry leaf-roller, *Ancylis comptana* Frohl., and its periodical outbreaks references to its parasites are rather

scarce. The leaf-roller is distributed over the greater part of the country and though usually common wherever strawberries are grown, is not a serious pest except during periodical, local outbreaks. This would indicate that normally the natural enemies exert a sufficient check to prevent serious injury. Since the leaf-roller is common in central Ohio and yet ordinarily does not cause serious damage, a study was undertaken in the fall of 1923 and continued through 1924 to determine if possible some of the factors which are normally involved in holding the insect in check.

Weed (1888) described *Cremastus cookii* and *Glypta phoxopteridis* reared from the leaf-roller in Illinois. Vierick (1911) described *Microgaster comptanae* reared from the leaf-roller at Rocky Ford, Colorado. Webster (1918) reports the only parasite observed in Iowa was *Iseropus alboricta* Cress. Rohwer (1923) described *Macrocentrus ancylivora* reared from the leaf-roller in New Jersey. Only one of the above was found parasitizing the leaf-roller in Ohio. It is possible that all were present but only *Microgaster comptanae* Vier. was taken. Five additional species of Hymenopterous parasites were reared from the leaf-roller and three more are listed as probable parasites. One Tachinid fly was observed in the field to be parasitic upon the leaf-roller.

Sympiesis ancylae Gir.: A single specimen of *Sympiesis ancylae* Gir. was reared from *Ancylis comptana* Frohl., taken in the field. The parasite larva emerged from the host and pupated June 20, and the adult emerged June 28, making the length of the pupal stage eight days. The adult died July 3. It was described by Girault from a specimen reared from the genus *Ancylis*.

Microgaster comptanae Vier.: This parasite was taken in the fall of 1923 and was common throughout the season of 1924. It was also reared from the overwintering generation and was taken from both larvae and pupae. The larval parasite spins a white silken cocoon in which it pupates. It was described by Vierick (1909) reared from the leaf-roller at Rocky Ford, Colorado.

Epirhyssalus atriceps (Ashm.): An undetermined larva feeding on strawberry was collected in the field June 18 which was parasitized by ten specimens of *Epirhyssalus atriceps* Ashm., and a single Tachinid. It is possible that this larva was either *Platynota flavedana* Clem. or *Cacoecia parallela* Rob. which were found feeding on strawberry. July 1, a larvae of the leafroller, *Ancylis comptana* Frohl. was taken from the field which was parasitized by three individuals of *Epirhyssalus atriceps* Ashm. This parasite was described from a specimen reared from a Tortricid, *Cacoecia rosaceana* Harris.

Elacterus aeneoniger Gir.: This was one of the most common of the leaf-roller parasites. From one to four individuals were reared from a single larva. The pupa is naked and the stage lasts from five to eight days. The larval parasite emerges from the host and pupates in the folded leaf passing the winter in this stage.

Cryptus incertus (Cress.): Several specimens of this parasite were taken during July from the leaf-roller. The specimens were all unusually small.

Pleurotropis sexdentatus Gir.: As high as seven specimens were reared from a single leaf-roller. It is possible that this may be a hyperparasite.

Meteorus trachynotus Vier.: This is listed as a probable parasite since several specimens were reared from a mass of folded leaves containing leaf-roller larvae. It was not actually observed to emerge from the leaf-roller larvae.

Itoplectus conquisitor Say.: A single unusually small specimen ofth is common parasite was reared from a mass of folded leaves containing leaf-roller larvae and so is recorded as a possible parasite. The parasite has been reared from forty-nine insect hosts according to Cushman (1920).

Spilochalcis nelumbis Cress.: This is also recorded as a possible parasite of the leaf-roller since a single individual was taken from a mass of folded leaves containing leaf-roller larvae.

Exoriste pyste Walker (Tachinidae): A leaf-roller larva was taken in the field which was parasitized by a Tachinid, *Exorista pyste* (Walker). The egg was sunk in the epidermis of the mesothorax, around which the epidermis turned black in streaks.

Egg.—Elongate, oval, twice as long as wide; nearly pure white but with a slight creamy tinge; fine hexagonal markings like a fine network. Length .60 mm., width .30 mm.

The larva pupated July 15 and the egg shell slid off with the last larval skin. The host pupa died July 17 and the parasite emerged from the pupa July 18.

Puparium.—Creamy yellow in color; anterior end broader than posterior by one-half, with two widely separated tubercles; the two anal breathing spiracles close together, black, reticulate. Length 3.25 mm., width 1.3 mm.

The adult fly emerged from the puparium July 26 making the length of the pupal stage about eight days. This Tachinid has been reared from a number of Pyralids and Tortricids according to Coquillet (1897). The adult was described bv Walker (1840).

Conclusions

In none on the writings on the outbreaks of the strawberry leaf-roller *Ancylis comptana* Frohl. have parasites been mentioned as common. Webster (1918) reports that during the five years that the leaf-roller was studied in Iowa, at no time did natural enemies appear in abundance and listed but a single species of parasite. Wadley (1922) mentioned none from the Missouri valley.

In central Ohio the leaf-roller is common but is not a serious pest and apparently causes little injury. The only plausible explanation of this fact is that it is normally held in check by its natural enemies. Six species of Hymenopterous parasites were reared from the leaf-roller and three more are listed as probable parasites in addition to one Tachinid. Four species have been reported in the literature which were not obtained in this study and undoubtedly further rearing would add to the list.

The writer wishes to express his appreciation to Dr. D. M. DeLong under whose supervision this study has been carried on, and to Mr. S. A. Rohwer through whose courtesy the parasites were determined.

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NATURAL ENEMIES OF THE PEA APHID (*ILLINOIA PISI* KALT.); THEIR ABUNDANCE AND DISTRIBUTION IN WISCONSIN

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Abstract

The pea aphid predators are many and varied. Studies this past year at Columbus, Wis., gave some idea of the abundance of certain groups and the relative importance of others. Numerous species not heretofore mentioned are included in the list.

From time to time numerous predators and parasites of the pea aphid have been listed but no intensive study has been undertaken to determine the relative importance of these forms and methods of handling as an aid in the control of the louse.

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The preliminary report here given is the result of studies at Columbus, Wisconsin during the season of 1924. The studies are a part of the Federal project organized to study the control and bionomics of the Pea Aphid.

Determination and Distribution of the Species

The following classified list includes only those forms found attacking the pea aphid.

Table 1. A List of Natural Enemies Found Attacking the Pea Aphid, (*Illinoia pisi* Kalt.) in Wisconsin During 1924.

NAME OF PREDATOR	LOCALITIES	GROUP	REMARKS
Entomophthora aphidis Hoff.	General	Fungus	Determined by Thaxter Most Important
Mite	Columbus	Arachnida	Undetermined
Spiders	Columbus Madison	Arachnida	Undetermined Common on alfalfa
Chrysopa oculata Say	General	Neuroptera	Determined by Smith Common late in season
Chrysopa plorobunda Fitch	Columbus	Neuroptera	Uncommon
Nabus ferus L.	General	Hemiptera	Quite common
Triphleps insidiosus Say	Columbus Madison	Hemiptera	
Hippodamia parenthesis Say	General	Coleoptera	
Hippodamia 13-punctata L.	General	Coleoptera	
Hippodamia convergens Guer.	Columbus Madison	Coleoptera	
Hippodamia glacialis Fab.	Columbus	Coleoptera	Rare
Cerotomegilla fuscilabris Muls.	General	Coleoptera	Most important of the lady beetles especially on alfalfa.
Coccinella trifasciata L.	Door County	Coleoptera	Common north
Coccinella sanguinea L.	Columbus	Coleoptera	Rare
Coccinella 9-notata Herbst.	General	Coleoptera	Common
Hyperaspis undulata Say	Madison	Coleoptera	Rare
Scymnus sp.	Columbus	Coleoptera	Quite common
Podabrus tomentosus Say.	Columbus	Coleoptera	Common
Podabrus rugulosus Lec.	Door County	Coleoptera	Very rare
Cantharis carolinus Fab.	Columbus	Coleoptera	Quite common
Cantharis lineola Fab.	Columbus	Coleoptera	Rare
Syrphus americanus Wied. and var. *vinelandii* Cur.	General	Diptera	Very common
Syrphus ribesii L. and var. *vittafrons* Sh.	General	Diptera	Abundant
Syrphus rectus O. S.	General	Diptera	Abundant
Syrphus torvus O. S.	Columbus	Diptera	Uncommon
Syrphus perplexus Osb.	Columbus	Diptera	Scarce
Epistrophe grossulariae Meig.	Columbus	Diptera	Rare
Allograpta obliqua Say.	General	Diptera	Abundant
Sphaerophoria scripta L.	General	Diptera	Both
Sphaerophoria cylindrica Say	General	Diptera	Common
Platychirus hyperboreus Staeg.	General	Diptera	Abundant
Platychirus quadratus Say	Columbus	Diptera	Very uncommon on pea aphids
Platychirus angustatus Zett.	Columbus	Diptera	Rare
Aphidius rosae Hal.	General	Hymenoptera	Common on alfalfa
Praon simulans Prov.	General	Hymenoptera	Common on alfalfa
Praon alaskensis Ashm.	Columbus	Hymenoptera	Rare

Abundance of Groups

Considerable time was spent trying to determine if possible the numbers of various groups per acre. While the figures so far obtained are not always complete, some idea of the abundance of certain groups is here presented.

Two methods were followed: (1) Definite areas were selected varying from 4 square feet to 180 square feet and the predacious and parasitic forms counted in those areas. In the smaller areas counting was done in the field, but when larger spaces were selected the crop was cut, taken to the laboratory in bags, and the specimens carefully counted. From these figures direct computation was then made to secure acreage basis. (2) The second method consisted in using the "aphidozer;" all specimens were counted after sweeping a definite area, in most cases an acre in extent. In Table 2 the more significant counts are presented.

Counts of the adult syrphid flies were necessarily not made while larvae, pupae, and adults of the lady beetles were counted. From the figures given it would appear that the lady beetles are most important. This is true early in the season, but when heavy infestations of the aphid occur, the syrphids are far more plentiful. In plot ten there were actually counted 1,258 coccinellids, including adults, larvae, and pupae; while there were 9,680 syrphids, all larvae. It is significant that no syrphid pupae were collected by the aphidozer.

No attempt was made to count the fungous forms in plots 8, 10, and 11. In plot 10 only the syrphids and coccinellids were counted. The chrysopids were a factor only late in the season.

On June 23, 516 syrphid larvae were collected from an alfalfa field and caged for rearing. This experiment gives some idea of the relative abundance of the syrphids. Of the 516, only 456 became adults, the rest died or were parasitized.

Syrphus americanus was the most common species with *S. ribesii* a close second. Only one specimen each was reared of *Platychirus angustatus* and *P. quadratus*.

Practical Methods of Handling the Predators as Aids to Control of the Aphis

The only method of artificially handling the pea aphis predators is to release them back into the fields after they are collected along with the lice in the aphidozer. When the lice are first collected the predators are mixed in promiscuously with all the aphids. Three distinct methods were tested for releasing them:

TABLE 2. ABUNDANCE OF THE NATURAL ENEMIES OF THE PEA APHID (*Illinoia pisi* KALT.) IN WISCONSIN 1924

Plot No.	Date	Host Plant	Area Counted	Rate per acre of						
				Coccinellidae	Syrphidae	Fungus	Aphidius	Praon	Chrysopidae	Aphids
1	May 12	Alfalfa	4 sq. ft.	54,460	——	——	108,900	——	——	——
2	May 25	Alfalfa	10 sq. ft.	34,848	——	——	13,068	——	——	——
3	May 25	Alfalfa	9 sq. ft.	19,360	——	4,840	33,880	——	——	135,520
4	May 25	Sweet Clover	9 sq. ft.	19,360	4,840	——	——	——	——	111,320
5	May 27	Red Clover	9 sq. ft.	4,840	——	4,840	——	14,520	——	174,440
6	May 28	Alfalfa	9 sq. ft.	96,800	——	4,840	48,400	4,840	——	72,600
7	May 28	Alfalfa	9 sq. ft.	29,040	——	106,480	24,200	82,280	——	1,082,160
8	May 31	Alfalfa	9 sq. ft.	24,200	——	——	29,240	9,680	——	121,000
9	May 31	Alfalfa	9 sq. ft.	33,880	——	183,920	19,360	87,120	——	2,095,720
10	June 23	Alfalfa	44,225 sq. ft.	1,258	9,680	——	——	——	——	——
11	July 29	Peas	180 sq. ft.	13,794	9,196	——	15,004	7,018	726	——

TABLE 3. RELATIVE IMPORTANCE OF THE SPECIES OF *Syrphidae* ATTACKING THE PEA APHID (*Illinoia pisi* Kalt.) IN WISCONSIN, 1924.

Syrphid	No.	Syrphid	No.
Syrphus americanus	123	*Epistrophe grossulariae*	3
Syrphus americanus var. *vinelandii*	29	*Allograpta obliqua*	24
Syrphus ribesii	25	*Sphaerophoria scripta*	53
Syrphus ribesii var. *vittafrons*	96	*Sphaerophoria cylindrica*	13
Syrphus rectus	30	*Platychirus hyperboreus*	47
Syrphus perplexus	4	*Platychirus quadratus*	1
Syrphus torvus	3	*Platychirus angustatus*	1

1.—The mass of material from the aphidozer was spread out in a thin layer in shallow trays. Over the top was placed a white cloth on which the syrphid larvae and other predators crawled. This cover was then shaken in the field and the forms thus released. This method was not entirely satisfactory, as too many of the forms did not crawl on to the cover.

2.—The material from the aphidozer was also first sifted thru a coarse screen to remove weeds and larger leaves; it was then treated with cold water and the lice floated while the syrphid larvae, particularly, sank to the bottom. After this separation, the top was poured off and the syrphids released. Large numbers of these larvae were then kept for rearing to note the effect of the cold water upon them. Most all of the specimens lived and developed to normal adults.

3.—It was also noticed that the aphids soon died if placed into a container, such as a tall can or pail. From this mass 100 syrphid larvae were selected (after standing over night) and reared to maturity. Only three died, the rest produced adults. Thus, if the mass of collected material is allowed to stand for an hour or two, it could be then scattered thinly back into the field and a large number of the predators would live, while the aphids themselves would die.

STATUS OF THE JAPANESE BEETLE IN 1924[1]

By LOREN B. SMITH, *Entomologist U. S. Department of Agriculture*

ABSTRACT

The Japanese beetle, *Popillia japonica*, increased the area of its distribution during the summer of 1924 to include approximately 5,122 square miles. One infestation of beetles was found near Milton, Penna., a point about 150 miles distant from the main area of infestation. During the summer of 1924 there occurred a migrational flight of the Japanese beetles. About seventy-five per cent of the beetles on the wing at that time proved to be females and the flight lasted approximately four days. During this time the beetles swarmed through the business and residential districts of Philadelphia and outlying points, and it is believed that the majority of the bee-

[1]Contribution No. 5 from the Japanese Beetle Laboratory, Riverton, N. J.

tles must have flown at least five to seven miles before reaching the city. During this time the insects were alighting on freight cars and vehicles of all kinds, and undoubtedly beetles were carried to some distant points. Methods have been devised for treating the soil to control the larvae which have been exceedingly effective. It has been possible to consistently treat the soil about the roots of nursery stock and obtain a perfect kill of the grubs over 18" below the surface of the soil. It is now possible to treat golf greens infested by the grubs at a relatively small expense, since an outfit has been devised which eliminates the use of large mixing tanks and reduces the labor cost nearly one-half in the application of the dilute emulsion. Progress has also been made in the control of the adult beetle. The finding of a constituent of the beetle's food plants which is highly attractive to the adult insect is being developed as a means of overcoming the repellency of the various poison sprays which have been used. Sufficient data were obtained during the past summer to indicate that the Tachinid parasite of the adult Japanese beetle, *Centeter cinerea* Aldrich, has become established over an area of approximately 12 square miles by the end of the season of 1924. The situation as far as the control of the Japanese beetle is concerned looks most hopeful. As conditions are at the present time the insect is probably as well, if not more effectively controlled, than are many of the more common insect pests.

The Japanese beetle increased the area of its distribution from 2,440 square miles to 5,122 square miles during the season of 1924. This was less in proportion than it has been for the past several years. The insect now sparsely occurs over the entire portion of New Jersey south of the present quarantine line. In the northern part of the State it has passed Princeton and has been found at a point about 5 miles south of New Brunswick. Although thoroughly scouted, the area along the coast north of Barnegat City has been found free from infestation.

In Pennsylvania the beetle has spread outward through most of the border townships included by the 1924 quarantine line. Except in the case of a few infestations extending out as far as Pottsville in the west, the area of distribution has not extended much beyond the regulated townships during the past season.

Delaware became infested in 1924 and beetles have been found throughout Brandywine Township and the City of Wilmington. Three beetles were found by scouts on Montgomery's Island in the Susquehanna River, near Milton, Pa., a point about 150 miles distant from the Japanese beetle area. It is not known how the infestation was started inasmuch as there have been no records of nursery stock shipments or shipments of farm produce from the infested area to Montgomery's Island. As it happens, there is a baseball park on the island and it is thought likely that local baseball teams from Philadelphia or its environs in driving to Montgomery's Island carried a few beetles in their machines. It is quite possible that some automobile tourists passing through

the infested area have camped on the island for a night and accidentally carried beetles there in the machines or luggage. This is the only infestation thus far recorded at any distance from the main eastern Pennsylvania-New Jersey area.

In July, 1923 and 1924, there occurred what may be considered distributional flights of the female Japanese beetles. A year ago, this period of great activity lasted only for a little more than one day. This season, however, the flight lasted for 4 days and during this time the beetles swarmed through the business and residential districts of Philadelphia and outlying points. The majority of the beetles in flight were females and, in the case of those arriving in the business districts of Philadelphia, it is believed that they must have flown at least 5 to 7 miles before reaching the City.

The area of heavy infestation was enlarged this year to include about twice the area of 1923. This is indicated by the fact that in 1923 two golf courses suffered injury by the grubs of the Japanese beetle while in 1924 it was necessary to apply the treatments to no less than 4 courses in New Jersey. This condition has not as yet extended sufficiently into Pennsylvania to cause severe injury to any of the golf courses in that State.

Inasmuch as no method of treating golf greens is known whereby the female beetles are prevented from depositing their eggs in these locations, the damage by the grubs would have been more severe during the past autumn than in any previous season. Such injury was prevented through the destruction of the grubs by artificial means before they had an opportunity to destroy extensive areas of sod. It has been observed for several years that certain localities will be heavily infested by the adult beetles, while others will have very few beetles present. A drive therefore through western New Jersey may disclose slight damage caused by these insects. As a result of improved methods of control and the more general application of protective sprays there was less total injury by the adult beetles in 1924 than there was in 1923.

Among the various treatments which have been developed for the control of the larvae in soil, a dilute carbon-disulphide emulsion has been found most satisfactory. With this material it has been possible to obtain a complete kill of the Japanese beetle larvae under various soil conditions to a depth of 18 inches below the surface. The use of carbon disulphide as a gas has been developed and it is now possible to fumigate soil-balls about the roots of various types of nursery stock in such a manner as to destroy all living Japanese beetle larvae without injury to the

plants. It was found that applications of powdered arsenate of lead at the rate of 1,500 pounds to the acre, carefully worked into the soil until it was uniformly distributed, gave a satisfactory kill of the grubs. Investigations are progressing along the lines of general control of the larvae under field conditions. It is now possible to treat golf greens infested by the grubs at a relatively small expense. The use of carbon disulphide emulsion for this purpose was reported last year. Since that time, however, an outfit has been devised by a commercial concern working in cooperation with the laboratory, which will mix the carbon disulphide emulsion and water in the proper amounts, thus eliminating the use of large mixing tanks or other containers.

An interesting problem during the past year has been a study of the effect of carbon disulphide treatments on soil microorganisms. The results indicate that when carbon disulphide is applied to the soil, the floral and faunal balances are upset for the time being and, before readjustment is complete, increased amounts of plant food are made available, which results in a stimulation of plant growth. The stimulating effect of carbon disulphide upon plant growth has been noted for several years but the cause of this is not entirely understood. Investigations are now in progress to find a soil insecticide which is sufficiently cheap and satisfactory to apply under field conditions over considerable areas.

Considerable progress has been made on the control of the adult beetle. During the summer of 1923, under experimental conditions, a mixture of lead arsenate and lead oleate gave very promising results. Large amounts of this mixture, known as Coated Arsenate of Lead, have been used during the past season with most encouraging results. The beetles eat it more readily than acid arsenate of lead or arsenate of lead and flour, and moreover higher percentages of kill are obtained. In addition an attractent has been found which furthers possibilities in the use of traps and poisoned baits. Investigations are in progress leading toward the discovery of a repellent which will protect ripening fruit, since it is not advisable to spray fruit at this stage with an arsenical. We are also endeavoring to develop an adherent poison dust which will be as satisfactory and capable of being substituted for the sprays now recommended.

The work on the introduction of parasites of the Japanese beetle from Japan has been justified through the establishment of one species of Tachinid (*Centeter cinerea*). This was introduced during 1922 and 1923, and has become established over an area of approximately 12 square miles. Several other species have been introduced in quantity from

Japan. We are contemplating opening a laboratory in northern India, where several species of Popillia occur in abundance, for the purpose of importing from that region any parasites which may seem to be desirable. In addition, the work will be continued in Japan, Korea and the Yangtse Valley in China.

During the season of 1924 studies of the various microorganisms affecting the larvae reveal the fact that several species of bacteria and fungi are playing a more important role each year in the natural control of the larvae. This is particularly true in areas where the infestation of larvae has been heavy for two or three years.

Unfortunately, during the last two or three years, the Japanese beetle has received considerable undesirable publicity. This has extended from the newspapers and trade journals to certain official publications. The result has been to arouse a fear of the Japanese beetle out of all proportion to the conditions as they actually exist. The progress made by the research organization of the Japanese Beetle Laboratory during the last two years changes the entire aspect in regard to the seriousness of this pest. In view of this the writer desires to leave with you the thought expressed in the final paragraph of a paper now in press, dealing with all phases of the Japanese beetle problem, which is as follows: "The outlook at the present time is most hopeful. The development of a spray material which is giving excellent protection to plants as well as a definite kill of the insects, and the finding of effective methods of application afford the fruit growers and others a means of preventing serious losses. The devising of a means of soil treatment for the control of the grubs offers relief to those who have been suffering losses to their sod lands. The establishment of at least one species of parasite of the Japanese beetle in this country will undoubtedly result in a gradual diminution in numbers of the beetle. There is every reason to believe that the Japanese beetle will gradually be brought under control and its injuries almost, if not entirely, prevented."

PRACTICAL FIELD CONTROL OF THE COMMON BEAN WEEVIL, *BRUCHUS OBTECTUS* SAY

By A. O. Larson, and C. K. Fisher, *Stored Product Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture*

Abstract

This paper gives the results obtained by the writers while investigating the practicability of controlling the common bean weevil, *Bruchus obtectus*, commercially in the field in the Chino District of Southern California.

While the bean weevils were not completely eradicated the infestation was materially reduced. Indications are that the amount of infestation at harvest is proportional to the number of weevils that have been liberated within flying distance of the fields during the time the beans have been ripening, and that complete cooperation in preventing their breeding in dry beans during the summer would eliminate the weevils from the growing crop. Where a few people are careless about disposal of split beans, screenings and infested beans, near-by crops are endangered. It does not appear that large numbers of weevils fly long distances.

A survey made in 1922[1] showed that the Chino district of Southern California was admirably adapted for a demonstration of bean weevil control. Red Kidney beans and Blackeyed cowpeas were planted from April 6 to July 10, while Kentucky Wonders and other varieties were planted over a longer period of time. Some were ripening while others were being planted. These varieties are all susceptible to the attacks of *Bruchus obtectus*. This long ripening season made it possible for weevils to go from infested beans in storage to fields of ripening beans for a period of several months. It also made it possible for two or more generations of weevils to develop in the field, flying from the early beans to the later ones. It was found that at least 85 per cent of all lots of beans grown during that year were infested to some extent by weevils, and some lots were so badly damaged that they brought less than half price when sold.

Prevention of Weevil Injury Throughout the District

The prevention of weevil injury is primarily a community problem. For success it depends upon the cooperation of all the people in the district. Warehouses may contain thousands of bags of beans and the farmers' barns may contain small amounts of unused seed beans. Housewives may have a few pounds of beans stored where they become weevily and liberate large numbers of weevils. Warehouses where weevily beans are allowed to remain over summer are producing weevils to infest near-by growing crops as well as other stored beans which are uninfested.[2] Stacks of bean straw contain many beans which may produce several generations of weevils. Where there are so many sources of infestation, an individual bean grower has small chance to produce a clean crop of beans, but by cooperative efforts such sources of infestation can be removed. In order to get cooperative action in trying to prevent the spread of weevils from storage to the fields it was necessary to conduct an educational campaign to instruct the warehouse operators, farm-

[1] A. O. Larson, Bean Weevil Investigation in Chino District, Calif. Bean Grower's Journal, April, 1923, p. 82.

[2] A. O. Larson and C. K. Fisher. "The Possibilities of Weevil Development in Neglected Seeds in Warehouses." Journal of Ec. Ent. Dec. 1924.

ers, housewives, and all in that vicinity regarding the habits of the weevils. It was shown that as long as there were lots of infested seeds, just so long weevils were flying out to the fields to infest the new crop.

Breeding Places Should Be Removed Early in the Season

Stress was placed upon the importance of removing, early in the season, all possible breeding places—lots of beans of all varieties, together with splits and screenings. If small lots of beans were to be kept over the summer, it was advised that they be fumigated and placed in tight containers or that they be examined frequently for the presence of weevils. Where lots of infested beans were found, the weevils were destroyed by fumigation or heat or by feeding the infested beans to poultry or hogs.

Infestations Noted in Fields

Observations during the summer failed to show that weevils were at work in Mr. Wire's field which consisted of 4 acres of Red Kidneys and 15 acres of Blackeyed cowpeas together with 2 rows each of Extra Early Refugee, Stringless Green Pod and Lady Washington. The early and thorough cleanup of all beans in that neighborhood and the distance to other bean-growing sections were thought to account for the apparent absence of weevils. When numerous piles of beans were carefully examined and hand-shelled, however, it was found that a very light infestation had occurred. A total of 3,786 pods were hand-shelled. Of these only 5 were infested. One contained eggs, three contained larvae and one contained beans in which "windows"[3] were showing. The probable source of infestation was located. A bean threshing machine standing in Mr. Wire's yard was found to contain a few hundred beans. Some of these contained weevil emergence holes, while others contained living weevils in different stages of development. These few beans, probably one-half pound or less, had served as a source of infestation in which weevils were able to breed during the summer.

Weevils Found in Mr. Becraft's Field

On August 5, weevils of *Bruchus obtectus* were found ovipositing in some of the earliest ripened pods in Mr. Becraft's field. His crop consisted of 11½ acres of Red Kidneys and 7 acres of Blackeyed cowpeas together with a few rows of early Red Kidneys and other beans for variety tests. Later it was found that *B. quadrimaculatus* had oviposited

[3] "Windows" are the darkened spots beneath the seed coat showing where weevils are almost ready to emerge.

on some of the pods along the west side of the field, and *B. obtectus* was observed at work near the west and south sides.

Probable Sources of Infestation Located

On several occasions the common bean weevil was observed in this field, usually toward the southwest part. Although two rows of early Red Kidneys in the northeast part of the field were as far advanced—as well adapted for oviposition—as any other beans in the field, examination showed that they were not being infested by weevils nearly to the same extent as those at the northwest. Kentucky Wonders growing in his garden across the road west of the south part of the bean field were also infested with weevils. These observations indicated that the field was being infested from the south or west. Investigation revealed that one of his neighbors adjoining on the southwest had been unknowingly liberating weevils during the summer.

Infestation Determined at Threshing Time by Hand-shelled Beans

Piles of beans in different parts of the field were carefully examined and hand-shelled at threshing time. A total of 8,133 pods were thus shelled and the results of examination tabulated. These showed a great difference in the amount of infestation found in various parts of the field.

Nine hundred pounds of beans were secured from various parts of the field as they were threshed. Each bean of these lots was carefully examined early in October and again in November for evidence of weevil injury. The infested beans were removed and the extent of infestation tabulated. Summarizing the results of these examinations the early Red Kidneys showed an average of 9 weevily beans and 43 emerged weevils per pound, the southwest corner of the main crop of Red Kidneys averaged 5.86 weevily beans and 19.8 emerged weevils, while the same rows of beans a little farther north averaged 1.44 weevily beans and 5.5 emerged weevils per pound; the main crop Red Kidneys from the southeast part of the field averaged 0.66 weevily bean and 2.4 emerged weevils per pound; at the northeast they averaged 0.93 weevily bean and 2.3 emerged weevils per pound.

These examinations of the 900 pounds of beans corroborated the observations made while the beans were ripening and when the piles were being hand-shelled, that the weevils were attacking the southwest part of the field more than any other part.

Habits of Adult Weevils in the Field

When considered in connection with the distance from the source of infestation, the foregoing figures of recorded infestation indicate that this

weevil has a tendency to remain on the nearest suitable bean plants, a tendency which the senior writer has frequently noted. He has found a weevil on a plant, marked the location of the plant and gone back to it several times during the day. Weevils frequently seek refuge within an overripe pod which has split open. On August 28, when a field demonstration was held at Mr. Becraft's farm, the authors made use of these habits of the weevil. Before the crowd arrived they spent hours searching the field for weevils. They marked the location of the vines on which weevils were found and later had no trouble showing weevils at work excavating holes in which to oviposit, as well as weevils ovipositing and others at rest. Unless a field is badly infested a very careful examination is required to locate weevils at work.

The data obtained from the farms named indicate that one person can unknowingly injure his own crop or those of his neighbors to a great extent and emphasizes the necessity of preventing the spread of weevils during the summer.

Eggs that are in the Pods at Threshing Time do not Cause Injury to the Crop

In the process of threshing, the eggs of *B. obtectus* are brushed or blown away from the beans and are carried away with the dust and chaff among the straw where the young larvae die soon after hatching. This makes it desirable to thresh the beans as soon as they are ready. The beans containing weevils in the older stages at threshing time furnish the principal source of discernible infestation before the beans are recleaned and put on the market, but the beans containing the younger stages supply the weevils which usually cause the heavy losses in storage. There is always the chance, however, that adult weevils may fly from infested lots of beans to uninfested lots in the warehouse before as well as after they are recleaned.

A Decided Decrease in Amount of Injury

From the whole district a total of 46 samples were collected at threshing time.[4] Of these 4 were heavily infested, 12 showed a light infestation and 30 were free from weevil injury. A sample was thought to have a light infestation if only one bean was found to be weevily but if more than one weevily bean was found the sample was considered to have a heavy infestation. The heaviest infestation showed 8 weevily beans, or one out of each 715 beans in the sample. The samples indicated that

[4]The writers wish to thank the bean growers as well as the owners and operators of the 4 threshing machines for their hearty cooperation and assistance in securing these samples

only 35 per cent of the lots of beans were weevily, as compared to 85 per cent the previous year. In almost every case the growers' warehouse receipts failed to show that the beans were weevily even when our samples showed weevil injury. Most of the beans were sold for a good price without the necessity of paying fumigation charges. This was a decided reduction in weevil infestation when compared with former years.

An interesting feature brought out at threshing time was that where beans were found to be weevily, the source of infestation could be located. If the fields had ripened at the same time, those closest to the source of infestation were injured most. The heaviest infested lot grew immediately adjoining a neighbor's barn in which weevily Blackeyed cowpeas had remained all summer. The owner of the weevily cowpeas unknowingly distributed weevils to his own crop as well as to his neighbor's; his beans, however, were farther from the source of infestation and were not so badly infested. Had it not been for the infestation in the near-by fields at threshing time, the writers probably would not have found out that the weevily cowpeas had been in the barn.

Recommendations

In order to prevent the spread of weevils, all infested beans, screenings and splits should be fumigated or heated as early as possible.

They should be treated before the weevils begin to emerge instead of after many have gone to uninfested beans.

Bean strawstacks should not be allowed to remain over summer. If not used up in the winter they should be scattered and plowed under in the spring.

Warehouses should not distribute weevily seed beans because some are frequently left over after planting is finished. These, if uncared for, produce weevils which infest the crop.

The best time to protect the new crop of beans from weevil injury is during the spring and early summer. If during this time weevils are prevented from flying to the field the crop will be uninfested at harvest.

Where beans are kept over summer they should be inspected frequently and fumigated when necessary.

Beans should be threshed as soon as they are ready.

A little carelessness may cause a heavy infestation but proper cooperation in preventing the spread of weevils will insure weevil-free beans.

A PRACTICAL CONTROL FOR THE POMACE FLY[1]

By R. M. DeCoursey

ABSTRACT

Observations of the common pomace fly, *Drosophlia melanogaster* Meigen, around fruit markets, in grocery stores, and in homes, show that it is often a serious pest in such places. A simple trap, baited with fermented banana has been devised, which, under practical conditions, will furnish an adequate means of control, especially for indoor infestations.

The pomace fly, *Drosophila melanogaster* Meigen, is often a serious pest around cider mills, fruit markets, commission houses, and in homes, especially about the dining table and in the pantry where fruit is kept. The various means of control suggested have usually proved impractical or inadequate. The entomologist frequently receives inquiries relating to the control of the flies but is unable to recommend a reliable method.

The search for a substance capable of attracting pomace flies, first led to a series of tests with a number of substances ordinarily found in decaying fruits, such as; ethyl alcohol, amyl alcohol, acetic acid, tartaric acid, and citric acid. These substances were tested both individually and in combination at various dilutions.

In order to record favorable reactions toward a substance in a quantitative way, a trap was devised that would permit counting the number of flies attracted during a definite period. The trap used was a glass, cream test tube approximately five inches high with a diameter of about one inch. The cream tube was covered with a small glass funnel of slightly larger diameter than the tube itself. The neck of the funnel was removed so that the flies were not forced to walk down a long, narrow, glass tube in order to enter the trap. The substance to be tested relative to its attractiveness, was placed on a piece of moistened filter paper at the bottom of the trap. The flies, attracted by the bait, entered the trap through the funnel and were unable to find their way out.

The laboratory experiments were conducted in a series of five large, glass jars, all of equal size. The top of each jar was covered with a double layer of cheese cloth to prevent the escape of the flies but still allow circulation of air. Four or five traps together with a check trap containing distilled water, were placed in each jar, and a definite number of flies (usually fifty) were liberated in each jar. At the end of twenty-four hours the traps were removed and the attractiveness of each substance determined in a rough way by a count of the number of flies in each trap. These experiments showed that ethyl alcohol, acetic acid,

[1]Contribution from the Entomological Laboratories of the University of Illinois, No. 96.

tartaric acid, citric acid, and lactic acid were decidedly attractive even at low concentrations, but not sufficiently attractive to make them practical as a bait in a trap for control purposes.

The investigation was extended to include a series of volatile oils in an effort to find a single volatile substance which would be sufficiently attractive to lend itself to the purpose. Many of the volatile oils were found to be attractive in varying degrees. Among the most attractive were; phenyl ethyl alcohol, ethyl propionate, ethyl cinnamate, benzyl benzoate, benzophenone, methyl anthranilate, diethyl phthalate, coumarine, eugenol, and anethol. These also failed to show sufficient attractiveness to warrant their use as a bait for practical control work.

The most attractive of the volatile oils when compared with the attractive qualities of over-ripe fruits were found to be entirely inadequate for use as bait in a trap. The problem of determining the most attractive fermenting fruit therefore presented itself.

All the decaying fruits tried were found to be attractive to pomace flies. This attraction is thought to be due to fermentation products developed during the process of decay. Decaying fruits were found to be more attractive than sound fruits. Also, fruits artificially fermented with yeast were found to be more attractive than fruits undergoing a process of natural decay. Fermentation was induced more quickly and in much higher concentration by artificial yeast fermentation.

The odor of any particular fruit is apparently a minor factor in its attractive power. All fruits fermented with yeast are thought to develop about the same fermentation products. Therefore, fermenting fruit mixtures pass through a stage when they are superior in attractiveness to any other stage in the fermentation process of that fruit. Without this interpretation of the fermentation process and its relative attractiveness, the testing of the attractive qualities of various fruits leads only to confusion, for the comparison may be made while the fruits are at different stages of their attractive power. One fruit may be at the peak of its attractive power and another may not have reached its height of attractiveness or may have already passed it.

There is the widest variation in the way different fruits react to fermentation from the standpoint of adaptability to their use as bait in a trap. Many fruits such as apples and grapes when used in small quantities, ferment very quickly but they rapidly lose their attractive power and become dry and unattractive. The citrus fruits, on the other hand, ordinarily contain too large a percentage of water to make a satisfactory bait.

When fermented with yeast, banana appears to be the most attractive of the natural fruits. This attractiveness of banana is thought to depend largely upon a peculiarly favorable and rapid fermentation rather than upon any particular quality in the fruit itself. The rapidity

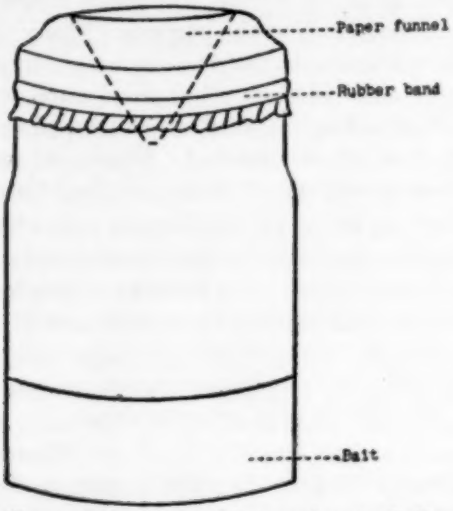

FIG. 13.—Pint Mason Jar Trap. The type used in experiments dealing particularly with control work.

of fermentation also depends upon the amount of yeast present, the temperature, and the amount of moisture.

Banana also has a longer period of attractiveness than other fruits tested. When sprinkled with yeast and used as bait in a trap, it continues to attract flies for at least two weeks. The number of trapped flies permitted to accumulate on the surface of the banana and yeast mixture, determines to a great extent, the period of usefulness of the trap. The rapidity of fermentation is also a factor.

The trap used (Fig. 13) in control work was constructed from either a pint or a quart Mason fruit jar, on the same plan as the laboratory traps, except that paper funnels were used instead of the small glass funnels which covered the cream tube traps. Newspaper or light weight wrapping paper folds easily and is very satisfactory for constructing the funnels.

Probably the easiest way to make a funnel for these jars is to cut a circular piece of paper about six inches in diameter, folding it twice through the middle so that there are four quadrants. Then, by overlapping one of these quadrants to a greater or less degree, a cone of the

proper size may be constructed. A small hole about three-sixteenths of an inch in diameter should be cut at the apex of the cone. A larger hole permits the escape of some of the flies and allows larger species of insects to enter. The hole should be carefully cut rather than torn because tearing usually leaves a rough edge of projecting fiders which may block the entrance. The funnel should be held tightly in place over the top of the jar by a rubber band or a string.

Two bananas were generally used as the attractive bait for each jar. One was mashed and put in the bottom of the jar. The other was peeled, broken in two, and laid on top of the mashed banana. This method prolongs the usefulness of the trap. When yeast is sprinkled over the fruit, fermentation begins more quickly on the mashed banana. The yeast also serves to crowd out undesirable molds. A third banana broken in two but not peeled, will prolong the attractive quality of the trap, but it was found to be better to clean the trap when the banana and yeast mixture became covered with dead flies, rather than have its attractiveness hindered by the accumulation. The banana mixture may be easily washed out with water and the trap can be baited again in a few minutes.

Probably the simplest method of killing the trapped flies is to put the trap in an oven and heat it for a short time. It takes considerable time for the heat to penetrate the moist banana and yeast mixture and if the larvæ are killed, the heating must be extended over a longer period. The larvæ may also be easily killed by pouring hot water into the trap. These methods are suggested merely as the simplest and most practical to recommend to the housewife. The heating does not injure the attractive quality of the banana to any great extent unless the mixture is actually cooked.

The efficiency of the trap has been tested in fruit stores, and in homes, as well as in the laboratory and it is believed that its value as a control measure for pomace flies has been adequately demonstrated. Traps set in a fruit store proved their efficiency in the presence of a wide variety of attractive fruits and under such conditions that their work was constantly disturbed by the passing of customers in the store. One of these traps contained 1334 flies by actual count after being set four days. Another contained 868 flies after a period of three days.

Occasionally, when the flies were breeding rapidly in some nearby infestation, the traps were filled mainly from the steady inflow of young flies. In such cases the source of the infestation should be located and destroyed.

Traps set out of doors, like outdoor house fly traps, will catch a great number of flies but cannot be expected to give a control as long as the source of the infestation remains undisturbed.

METHODS OF CONTROL FOR TWO SHADE-TREE PESTS

By GLENN W. HERRICK

ABSTRACT

The maple bladder-gall (*Phyllocoptes quadripes*) is readily susceptible to applications of lime-sulphur while the spruce gall-aphid (*Chermes abietis*) is readily susceptible to applications of lime-sulphur and of oil emulsions. Experimental work of the past three years demonstrate the ease with which these pests may be controlled. Evidence at this time, however, appears to indicate that certain proprietary oil emulsions may cause some shedding of the foliage on spruces although the effect does not seem serious.

The spruce gall-aphid (*Chermes abietis*) lives over the winter as a very small nymph ensconced in crevices of the stem nearly always at the bases of terminal buds. The body is without protection save for a slight coating of wax threads in some individuals while in many there is scarcely any development of the threads. These latter individuals resemble grains of gunpowder and they are in the majority.

For many years this aphid has been a pest to the Norway spruce which is much used, in the vicinity of Ithaca, at least, for hedges and for ornamental effect on lawns. The galls produce ragged, unsightly trees and prevent the young trees, at least, from making proper growth and in some instances certainly act as the most effective agent in causing the ultimate death of the infested plant. For some years the writer has been spraying Norway spruces for this aphid and last spring an opportunity was offered to make a test on a larger scale.The results corroborated the former isolated attempts and seem worth recording in more permanent form.

A hedge of Norway spruce trees about five feet high which runs along one end and about half way of the length of one side of the Prudence Risley Dormitory grounds at Cornell University has been badly infested with the gall-aphid and the infestation has been gradually increasing until some of the young trees have nearly succumbed to the injuries inflicted by the insect. The hedge, which has a total length of about 550 feet, offered a fine opportunity for trying some control measures.

On Apr. 9, 1924, this hedge was thoroughly sprayed with powdered lime-sulphur (Sherwin Williams) at the rate of 16½ pounds to 50 gallons of water. The hedge was sprayed from both sides and care was taken to coat the branches thoroughly with the liquid. The writer has had this hedge under observation throughout the season and has not yet been able to find a single developing fresh gall. The caretaker of the grounds, who is interested in the problem and aided in the spraying,

pruned the hedge during July and while doing so kept a sharp lookout for galls. He failed to find a single one and since he pruned each tree in a rather careful manner it is likely that he would have seen the galls if any had been present.

The writer has along the front border of his own grounds a hedge of Norway spruce the trees of which are about 5 feet high. These small trees have also been badly infested with the gall-aphid. On April 21, 1924, I sprayed this hedge, which is about 75 feet long, with Sunoco oil at the rate of 1 part to 20 parts of water. Warm water was used in making the emulsion and the oil emulsified readily forming a very satisfactory milky emulsion. The hedge was sprayed from both sides in a very thorough manner with an abundance of liquid. During the summer, frequent examinations have been made of the trees in search of developing galls. The writer has been unable to find any signs of the presence of the aphids and no fresh galls have been discovered. It should be remarked that it began to rain about 3 P. M. on the afternoon of the day on which the trees were sprayed and it continued to drizzle most of the afternoon.

In the case of an individual tree of larger size sprayed on Apr. 5, with Sunoco oil at the rate of 1 gallon to 15 gallons of water, five freshly developing galls were found, one on June 10 at the tip end of a side branch and four at the topmost end of the leader. Unquestionably the tip ends of these branches were left untouched by the oil. The lower branches of this tree were covered with old galls and the hibernating nymphs were abundant on nearly all of the branches at the time of spraying. No new galls, other than those mentioned, have appeared on the tree.

All of the trees sprayed with oil were watched during the summer and fall for possible signs of injury but no evidence of the slightest ill effect was observed until early in the following March, nearly a year after the application. Then, to my surprise, I noted that the snow underneath the trees was covered with leaves of the spruces and on examination found that there appeared to be an abnormal shedding of the foliage. The ends of the branches of nearly all of the young trees in the hedge-row were bare of leaves so that the effect was quite noticeable. At this writing, the middle of March, the defoliation does not seem to be progressive and does not appear to be serious although it does give the hedge a somewhat unthrifty and untidy appearance. Indeed, I do not feel positive that the effect is due to the oil although I can find no evidence of abnormal shedding of foliage on unsprayed spruce trees, many of which I

have examined. At this time, July 25, 1925, the trees are in excellent condition and the hedge shows no injury.

Dr. W. E. Britton says,[1] regarding the control of this gall-aphid, that spruce trees have been effectively sprayed for several years with miscible oil in the fall and in April at 1 to 20 and that there has never been any injury to the trees except once and this was probably due to not mixing the contents of the original package before dilution with water. It seems apparent that oil emulsions, miscible oils, and lime-sulphur, the latter either dry or liquid, are effective materials for the control of the spruce gall-aphid. The writer has obtained efficient results on a few trees at different times with the concentrated solutions of lime-sulphur at winter strengths, one gallon to 8 gallons of water, when the solution tested 32° Baumé. The lime-sulphur may be somewhat objectionable because it tends to stain the foliage of the spruce trees. At least, it gives the trees a whitewashed appearance which may persist for some time and to which some owners might object. The oils do not produce any discoloration of the foliage and if they do not produce marked injury to the trees such as may prohibit their use on spruces they are, I believe, preferable.

The writer has five soft maple trees on his lot, the leaves of which are always badly infested with the maple bladder-gall, (*Phyllocoptes quadripes*). In April, 1918, I sprayed one of the smaller trees with lime-sulphur at winter strengths, 1 gallon to 8 gallons of water when the concentrated solution tested 33° Baumé. The effect was very gratifying. The lime-sulphur reduced the infestation to almost nothing. It was difficult to find a leaf with a gall on it.

On April 12, 1919, I sprayed two of the larger trees before the buds started, with lime-sulphur at the same strength as in the foregoing instance. The leaves of these trees in previous years had been covered with galls of this mite. Examination of the leaves on the trees made from time to time during the season, showed that here again the mites had been most effectively destroyed. Scarcely a gall could be found on the foliage.

A third tree near by which was not sprayed was as badly infested as in former years for the leaves bore a multitude of the small pointed galls.

It would appear that lime-sulphur at dormant strength is practically a specific for this mite. It is probable that weaker strengths of the solution will prove equally efficient although we have not tested them.

[1]Britton, W. E. Twenty-second Report of the State Entomologist of Connecticut for 1922, p. 359, 1923.

THREE MIRIDS PREDACEOUS ON THE ROSE LEAF-HOPPER ON APPLE

By J. R. Stear, *Assistant Entomologist, Bureau Plant Industry, Harrisburg, Pa.*

Abstract

Three species of Mirids have been observed feeding on the rose leaf-hopper, *Typhlocyba rosae*, and are added to the list of its natural enemies. Notes are given as to abundance feeding habits and probable importance. Descriptive notes and drawings are also included.

It is well known that the family Miridae of the Heteroptera includes a number of injurious species, notably the tarnished plant-bug, *Lygus pratensis Linn.*, the light and dark red bugs of apple, *Lygidea mendax* Reut. and *Heterocordylus malinus* Reut., and the four-lined plant bug, *Poecilocapsus lineatus Fabr.* It is not so well known that some members of the family are beneficial, that many are predaceous and that some at least play two roles, feeding on plant juice or preying on other insects as occasion offers.

During the season of 1924 the writer while studying the rose leaf-hopper, *Typhlocyba rosae* Linn. on apple observed the occurrence of three species of Miridae in association with the leaf-hopper nymphs and feeding upon them to some extent. This was observed in widely scattered orchards in Franklin County, Pennsylvania. In the apple orchard where most of the observations were made, the rose leaf-hoppers were present in immense numbers in 1923. Eggs were laid in the apple bark in large numbers in the fall of 1923 and the first generation in 1924 gave promise of another heavy infestation. The second generation did not develop as expected. Counts of apple leaves made August 4th shortly after hatching of the second generation nymphs began, showed fifteen first stage nymphs to sixty leaves or one to four leaves. Counts made August 18th showed 214 nymphs on 54 leaves or four per leaf. Counts on August 26th gave 426 nymphs to 101 leaves or 4.2 nymphs per leaf while counts made on September 4th showed 1746 nymphs on 900 leaves or less than two per leaf. This reduction was not due to the transformation of nymphs to adults for from August 4th the time of the first count until September 4th practically all nymphs observed were in the first stage. Very few adults were present in the trees on September 4th. Counts made on that date showed but six adults to 204 leaves.

The reason for this reduction in numbers is not entirely clear to the writer. Why it was that in spite of continued hatching from August 4th until September 4th the number of nymphs increased very little

and finally showed a sharp decrease and why the nymphs did not develop, except in very small numbers, beyond the first or second stage is hard to explain.

A partial explanation may be the presence on the apple foliage of the three species of Miridae: *Plagiognathus politus* Uhl., *Hyaliodes vitripennis* Say and *Diaphnidia pellucida* Uhl., all of which were observed to feed upon the leaf-hopper nymphs. Only one observation was made on the feeding habits of *P. politus*. A nymph of this species was taken on apple foliage on June 2nd and caged for rearing. On June 14th while still in the nymph stage it was observed to feed upon a *T. rosae* nymph. No further observations were made on this species at that time and later on in the season no nymphs of this species were found. In August nymphs of *H. vitripennis* and *D. pellucida* were found to be very abundant on the apple foliage and on the 14th of August were observed to be feeding on leaf-hopper nymphs. On that date adults and all stages of nymphs of both species of Miridae were present.

D. pellucida was much more abundant than *H. vitripennis*. Counts to determine the number of nymphs were made on August 18th. On that date 113 leaves examined showed a total of 23 nymphs, 16 of which were *D. pellucida* and the remaining 7 *H. vitripennis*. In addition many adults of both species were present. No record was kept of the number of adults since at the time the count was made no nymphs had reached maturity in the cages and their identity was not known. On September 4th while dusting leaf-hoppers with 3% nicotine dust and cyanide A and B dusts, records were kept of the number of Mirids which fell on twenty paper plates 8¾ inches in diameter, under each tree. These are given in the following table.

ABUNDANCE AND RELATIVE NUMBERS OF H. VITRIPENNIS AND D. PELLUCIDA KILLED BY DUST

Tree No.	Treatment	No. of *H. vitripennis*	No. of *D. pellucida*
1	Nicotine 3%	2	11
2	Nicotine 3%	3	14
3	Nicotine 3%	1	21
4	Cyanide A	1	5
5	Cyanide A	1	4
6	Cyanide A	3	21
7	Cyanide B	0	8
8	Cyanide B	1	7
9	Cyanide B	0	7
Totals		12	98

Nymphs were very frequently observed feeding on leaf-hopper nymphs both in the field and in the cages but neither species is entirely predaceous. Nymphs and adults were often observed with their mouth

parts inserted in the leaf tissue and probably in the absence of the leaf-hopper nymphs or other small insects would thrive on foliage alone. To determine this point nymphs of both species were caged with foliage alone on the 27th of August. On the 3rd of September the nymphs transformed to adults. An attempt was made to determine the number of leaf-hopper nymphs one Mirid nymph would feed upon in 24 hours but on account of continual hatching of leaf-hopper nymphs from fresh material no accurate observations were made. Considering the numbers of *Hyaliodes vitripennis* and *Diaphnidia pellucida* present, however,

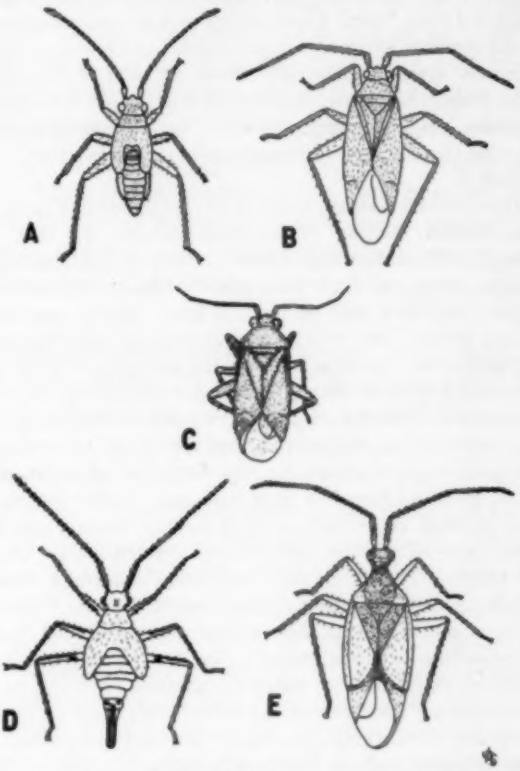

Fig. 14.—A, *Diaphnidia pellucida*, fifth stage nymph; *B*, *Diaphnidia pellucida*, adult; *C*, *Plagiognathus politus* adult; *D*, *Hyaliodes vitripennis*, fifth stage nymph; *E*, *Hyaliodes vitripennis*, adult.

it seems safe to conclude that these Mirids were responsible for a considerable part of the reduction in numbers of *Typhlocyba rosae*.

No field observations were made later than October 13th. At that time a very few adults of both species were present on the trees. No egg deposition or hibernation was observed.

Descriptions

During the progress of the work with *H. vitripennis* and *D. pellucida* nymphs of all stages and adults were collected and descriptive notes were made for all stages as well as drawings of the last nymphal and the adult stages. No descriptive notes or drawings were made of *P. politus* except for the adult stage.

Diaphnidia pellucida—First stage, length 1.3 mm., width .45 mm., color uniformly translucent with slight yellowish tinge. Second stage, length 1.6 mm., width .7 mm. Third stage, length 1.9 mm., width .7 mm. Fourth stage, length 2.5 mm., width .7 mm. Color of second, third and fourth stages same as for first stage. Fifth stage, length 3.2 mm., width 1 mm., color pale green, translucent, eyes white, apical segment of antennae, tibiae and tarsal segments translucent without greenish tinge. Proboscic pale green translucent. Basal segment of antennae with yellowish tinge. Adult, length 4.32 mm., width 1.47 mm., body pale green, translucent with pale pubescence, head, antennae, tibiae and tarsal segments light amber. This species is very active in all stages, running rapidly over the foliage and dropping off readily if disturbed.

Hyaliodes vitripennis—First stage, length 1.47 mm., width, .32 mm. Second stage, length, 1.93 mm., width, .6 mm. Third stage, length, 2.8 mm., width, .9 mm. Fourth stage, length, 3.27 mm., width 1.6 mm. Fifth stage, length 3.86 mm., width 1.6 mm. Body color green, two dark spots edged with carmine on dorsum of seventh abdominal segment on either side of median line. Apical segments of abdomen marked by a heavy median line which covers entire dorsum beyond the eight segment. The line begins as a carmine spot on the apical portion of the seventh segment, changes to dark brown on the eighth segment and shades to a reddish brown at the end of the abdomen. Femora are pale green marked with streaks of dark brown. Tibiae are dark brown with apical portion and tarsi pale. A reddish brown streak extends from the posterior margin of the eyes to the apical angles of the prothorax. Mesal portions of basal segments of antennae pale, lateral portions dark brown. Basal and apical portion of second segment reddish brown, middle portion pale translucent, basal portion of third and fourth segments pale translucent, apical portions reddish brown. Two prominent large black setae on median part of vertex posterior to the eyes. Adult length 4.77 mm., width 1.8 mm.[1] "hemelytra hyaline, glassy, with black or red bordering the scutellum, inner edge of clavus and corium, and across apex of corium to lateral margin, also dark on membrane, veins, and tip of cuneus; pronotum and antennae variously marked with red and black." The nymphs of this species are slow moving compared with those of *D. pellucida*. They have a peculiar habit of carrying the end of the abdomen, which is considerably lengthened, in an elevated position, scorpion fashion.

Plagiognathus politus[2] "Adult male, length 3.5 mm., width 1.3 mm.; ovate, shining black, femora dark fuscous to black, apices pale; rostrum slightly surpassing hind coxae, yellowish on middle; antennae black, tip of segment 1 pale, 3 and 4 pale or only tinged with fuscous; tibiae pale or yellowish, knees and spines with spots at base, black; clothed with simple pale or white pubescence. Female: length 3.8 mm., width 1.6 mm.; very similar to the male but more robust."

[1]Description from Hemiptera of Connecticut, Miridiae by Knight p. 434.
[2]Description from Hemiptera of Connecticut, Miridlae by Knight p. 478.

THE OCCURRENCE OF THE BEET LEAFHOPPER, *EUTETTIX TENELLA* BAKER, IN THE EASTERN U. S.

By D. M. DeLong, *Columbus, Ohio*

The beet leafhopper has long been known as a pest of the sugar beet in the west where it causes at certain times enormous losses to this crop especially in view of its relation to the transmission of the curly top disease. It has not however, been previously reported as occurring in the eastern United States. During the past few years the sugar beet has been grown more and more extensively as a field crop in western Ohio and adjoining states. This increase in acreage and production has brought up the question of the possibility of the leafhopper becoming a pest on the sugar beet in Ohio. At the present time, to the best of our knowledge, it does not occur in Ohio nor states adjoining where the sugar beet is grown. The entomologist has even been inclined to believe that there was no danger of it becoming established in the eastern United States, especially in this section. Recent observations and findings however have led the writer to believe that there may be more probability than was at first expected.

The insect has been known previously to occur only in Colorado, Utah, New Mexico, Arizona, California, southern Idaho and Oregon. It has been taken rather recently by the writer at Miami, Florida where it occurs abundantly both as nymph and adult on the sea purslane, (*Sesuvium portucastrum* L.) a fleshy, glabrous leaved, prostrate herb which occurs abundantly growing natively on the upper beach and sand dunes of the bays and inlets of the Atlantic Coast. The plant grows in the hot dry sand and vines for several feet in all directions, being a prominent member of the upper beach. In some cases the leaves were covered on the under surface with these individuals both mature and in several nymphal stages. They were collected during April, 1921.

In this connection it is interesting to note that Dr. Ball has reported it previously as occurring on greasewood (*Sarcobatus*), sea blite (*Dondia*) and species of *Atriplex*, Russian thistle. He states that it was found on greasewood during the egglaying period and suggests this as its original host. Severin reports the leafhopper as breeding on *Sesuvium sessile* and *Atriplex semibaccata*, in both cases having actually found nymphal individuals.

The sea purslane, *Sesuvium portucastrum*, is apparently a native food plant and is common, being distributed rather abundantly along the Atlantic coast from North Carolina to Florida and probably along the

Gulf coast. The possibility of the leafhopper becoming a pest on sugar beets in the east is questionable, but since it is already established here on a native food plant which is abundant and widely distributed, it is reasonable to believe that it will become a pest if sugar beets are grown in sufficient abundance and proximal to these native plants. The problem seems therefore to depend upon the factors of time and agricultural practice.

Scientific Notes

Rapidity of Flight of a Dragonfly (Anax?). During the summer of 1924 while in an automobile one day, a large dragonfly (*Anax* or *Æschna*, probably) darted into the road and flew just ahead of the car. It seemed a promising opportunity to obtain data on the speed in flight of this insect, if it would remain on the road, so the speed of the car was gradually increased and the speedometer watched. At 30 miles per hour the insect appeared to easily keep ahead of the car, but finally turned off the road, having been followed in this way for about a mile!

H. T. FERNALD, *Amherst, Mass.*

Flights of Onion Thrips. Large fields of onions are abundant near Amherst, Mass., onions being one of the chief crops in this portion of the Connecticut Valley. Several times when driving near these fields during July, multitudes of Onion Thrips have come into the car, even to the point of making it somewhat unpleasant riding. This has always happened at about (generally just after) sunset, and when it was nearly calm. On some occasions the sky was partly cloudy while on others it was clear. In every case I can recall, what wind there was, was from the southerly quarter.

H. T. FERNALD, *Amherst, Mass.*

Scarcity of the Imbricated Snout-Beetle (*Epicaerus imbricatus* Say) in the North. Since 1902 no reports of injury by this species have been received in the Bureau of Entomology, to the writer's knowledge. In 1899[1] an entomophagous fungus, *Sphaerophthalma globuliferum*, was observed attacking the adult by the writer, and Prof. B. T. Galloway, who identified it, wrote that there was little doubt of its being the cause of the beetle's death. Unless this fungus has caused depletion in the numbers of the insect up to this time, it must be due to climatic conditions or to the unusual activity of other natural agencies, such as birds, and to the inability of the beetle to spread by flight. In any case, the species appears to have completely disappeared in its more northern range, no specimens having been taken, so far as the writer can learn, for a period of over twenty years.

In regard to the inability of this species to hold its own, the writer expressed himself in 1903[2] as follows: "Eventually this snout-beetle will probably become rare, owing to its being wingless, when it may be replaced by other species having well developed wings."

F. H. CHITTENDEN

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[1]Bul. 23, n. s., Div. of Ent., U. S. Dept. Agriculture, 1900, p. 32.
[2]Bul. 43, Div. of Ent., U. S. Dept. Agriculture, p. 29.

A Tenebrionid Attacking Young Cotton. Fields of cotton in the eastern edge of Gillespie, and to some extent in Blanco and Hays Counties, Texas were attacked this spring by a small beetle less than one-fourth inch long. The damage was usually done soon after the cotton came out of the ground by the beetles gnawing upon the stem and in some instances eating the leaves, resulting in a bad stand. In the middle of the day the beetles were always found beneath the surface, but in the cooler part of the day they are to be seen on top of the ground. Specimens were sent to the National Museum for classification. They were referred to Mr. H. S. Barber of the Bureau of Entomology, U. S. Department of Agriculture, who made the following report:

> "A Tenebrionid not represented in the national collection, and about which nothing appears to be known. Probably a species of the genus *Steriphanus*, two species of which have been described from Laredo, and several others from farther west and south. They are wingless and probably indigenous and the species confined to rather narrowly limited habitat."

R. E. McDONALD, *Entomologist, State Department of Agriculture, Austin, Texas.*

Cull Onions As a Trap Crop for the Onion Maggot. An experiment with cull onions as a possible trap crop for the onion maggot, *Hylemyia antiqua*, was begun in the Racine, Wisconsin, onion district in 1924. Preliminary results gave evidence that useful results may follow this method of control.

Culls from the previous year's crop were planted very thickly in furrows along one side of several onion fields. The culls came up before the seeded onions, grew much faster, and were found to be attractive to the adult flies throughout the spring and a greater part of the summer.

An estimate of the value of these culls as a trap crop was made by placing screen cages 15 feet long over different sections of the culls for checking the numbers of the adults which emerged. It was found that the adults averaged 120 per foot of cull row.

The problem of destroying the puparia before emergence of the flies was solved by treating the rows of culls with a mixture of crude road oil (45 per cent), crank case drainings (45 per cent), kerosene (8 per cent), and creosote (2 per cent). This oil mixture was applied with a sprinkling can at the rate of one gallon to every 25 feet of row. By using the long cages to check emergence, it was found that this treatment killed 83 per cent of the different stages of the insect in the soil.

Careful counts of the maggots in cultivated onions near the rows of culls and at different distances from them, showed that the culls gave decided protection to the onions growing near them. In addition, the yield of onions grown near the culls was somewhat greater than that of onions grown at some distance from the trap rows.

The ease with which cull onions can be manipulated as a trap crop and the comparative simplicity of destroying the trapped maggots should make this method of control appeal to the onion growers and lead to its adoption as soon as the proper spacing of the cull rows has been determined.

JOHN E. DUDLEY, JR., *Bureau of Entomology, Madison, Wisc.*

Why Not Trap-Crops That Entrap? Under this title in the June number of the JOURNAL OF ECONOMIC ENTOMOLOGY, Mr. E. Graywood Smyth discusses two plants which he observed in Mexico and which are supposed to entrap insects.

It would be interesting to know what proportion of the Diptera and Hymenoptera that he observed on *Meibomia amans* (Wats) were primary parasites of importance in the control of injurious species.

As regards *Melinis minutiflora*, the well known Brazilian "Gordurs" grass known in many countries as "Molasses Grass," on account of its sticky excretion, this has been planted in both Florida and Porto Rico, where Mr. Smyth indicates its probable usefulness as a tick eradicator, for many years, but, here in "The Isle of Enchantment" at least, outside of its tick-*deterring* qualities, it does not compare in palatability with Guinea or Pará grass and its popularity is decidedly on the wane. Neither does the excretion of the plant *kill* the young ticks, as is generally supposed to be the case, simply deterring their crawling up upon it as a site upon which to await the passing bovine, as Geo. N. Wolcott has demonstrated by his observations at the Insular Experiment Station of Porto Rico. On 23rd October, 1923, Wolcott placed a batch of about 10,000 seed-ticks of *Margaropus annulatus australis* Fuller, hatched two or three days before from eggs laid 22nd—24th September, on the upper leaves of each of three types of plants—*Paspalum panicatum L.*, "molasses grass" and tobacco, the latter plant being also rather repellent to ticks. The following day he found that the ticks on the *Paspalum* had all congregated under the upper leaves, while those on the molasses grass and tobacco remained spread about on the leaves more or less as they had been placed thereon. During the several weeks following the larger part of the ticks on tobacco and molasses grass, which never seemed to attempt to hold on to the leaves, except for a few small batches which managed to congregate on the under surface of a few molasses grass leaves, were washed from the plants by very abundant rains. Meanwhile, the scattered ticks on these two plants, which had apparently made no attempt to hold on to the leaves, were shown by Wolcott to be thoroly alive, altho decidedly inactive, and, when washed to the ground, altho they made no attempt to climb back on to the molasses grass, did very readily climb upon a stake which was placed amongst them, from which they were once more transferred to molasses grass. A month later no ticks could be found on either molasses grass or tobacco and Wolcott, in order to determine if the ticks had really been killed by the plants in question, placed a half-inch stick, taller than the molasses grass, right in a stool of this grass. The following day he found that a very large number of ticks had ascended to the top of this stock, proving very conclusively that molasses grass does NOT kill ticks. Wolcott concludes:—

"It (molasses grass) does indirectly kill some ticks by preventing their having a convenient foothold from which to attach themselves to live stock and there is no doubt that in a pure culture of this grass development of seed ticks from females dropping from livestock would be largely prevented. But if in this field there are other plants growing to more or less the same height as the molasses grass, the larger part of the seed ticks would travel along the ground until they find these non-sticky plants, which they would of course mount and from there attach themselves to the animals just as if the molasses grass did not exist."

ARTHUR H. ROSENFELD,
Insular Experiment Station,
Rio Piedras, Porto Rico.

The Levuana Moth in Fiji. *Levuana iridescens* B-Baker is a serious pest of coconut palms in Fiji. Wherever this little purple moth has spread the leaves of the coconut have become brown and the crop has dwindled. The damage is done by the small,

brown-spotted, white caterpillar, which eats furrows in the leaves. As copra is, next to sugar, the chief production of Fiji, the situation is grave.

This pest is not thought to be a native of Fiji, though it has been known along the coasts of Viti Levu for many years. Here its ravages have been periodically bad, the groves partially recovering between attacks. But recently it has become more virulent and has spread to the neighboring islands including Ovalau.

The spread of the moth must be prevented. Neither Viti Levu nor Ovalau are important coconut regions. The principal copra producing sections are Taviuni and the Lau Islands. The danger lies in that most of the shipping to and from these islands passes thru Suva or Levuka, both of them in infested districts. At Levuka, on Ovalau, to in a measure prevent the moth being carried on the interisland cutters, the Department of Agriculture has ordered all coconut palms within a mile of the wharves chopped down.

But now the entomologists find that the caterpillars are not confined to the coconut palm. They have been noticed feeding on such plants as bananas, sugar cane, and even breadfruit leaves, as well as various kinds of palms. I saw the eggs of the moth on a banana leaf and the larvae happily engaged in furrowing its surface.

The Department of Agriculture is now fully aware of the seriousness of the menace. A reward of 5000 pounds was at first offered for a remedy, but recently withdrawn. The government entomologist, Mr. H. W. Simmonds, was sent to the New Hebrides and the Solomons in search of parasites. This year the services of Mr. A. M. Lea of the South Australian Museum were also secured. The cooperation of entomologists in all parts of the world has been sought in looking for the home of the moth or finding parasites of related species. The Department of Agriculture of the Federated Malay States succeeded in finding a closely allied Zygaenid moth (*Brachartona catoxantha*), also associated with coconuts, which had on it several parasites. Whether these would attack Levuana also is questionable.

During the year Mr. Lea visited Queensland, Torres Strait, New Guinea and the Malay regions. In Queensland he found another closely related moth, *Pollanisus subdolosus* Walker, which was parasitized by a Tachinid fly. Although this moth is associated with such plants as *Myrtus racemulosa* and *Eugenia carissoides*, the moth and caterpillar are extraordinarily like the coconut moth, and the Department is in hopes that the Tachinid may also attack Levuana.

Such artificial control as sprays, traps and smoke screens have been of no avail and have only served to spread the moths. If some natural enemy is not found, sooner or later the moth will become established on the copra producing islands of Fiji and that industry will be brought to a standstill.

E. H. Bryan, Jr., *Bishop Museum, Honolulu*

The Pink Bollworm iu Australia. All doubts as to whether or not we were dealing with *Platyedra gossypiella* Saunders, or an allied species, have been removed, Mr. E. Meyrick whose opinion was taken, having given it as his considered judgment that the Queensland species is *gossypiella* and no other.

There are two definite races established in Queensland pointing to the fact that the insect has been in the country for a considerable period. One race, differing only from the cotton race in that it is more deeply coloured and the colour evenly distributed, is established in species of wild Hibiscus apparently all over Queensland, although I am doubtful as to its northern range. This race, the Hibiscus race, has

not been found in cotton. The colouration of the cotton race is typical of *Platyedra gossypiella* in other parts of the world.

The differences from the type are that the crochets of the prolegs, in any case variable, form a pattern of two opposite arcs and do not form a complete horse-shoe as in the typical *gossypiella* larva. There is also a very strong chitinization of the setiferous plates in the body giving the larva a dark spotted appearance to the naked eye. This chitinization is also a variable as it is more strongly developed in Indian specimens than in Egyptian ones.

Pink Bollworm larvae from W. Australia and the Northern Territory are not atypical as is the Queensland form. This applies also to the specimens from Rabaul.

This is the present distribution of the Pink Bollworm in territory administered by the Commonwealth.

In Queensland the cotton race is confined to a line a little south of 26th parallel and stretches in places up to 150 miles inland. It is more than probable that the outbreak started near Rockhampton and the larvae from individuals which had acquired a taste for cotton were distributed to various parts of the country served by Rockhampton as a seed distributing centre.

We have now recorded it from The Callide where it was found on the State Farm (about 70 miles S. S. W. of Gladstone). The furthest north it has been found in the cotton is Cardwell on the coast a little below 18th parallel. This cotton feeding race has been found in Hibiscus in the vicinity of cotton fields but the bright red Hibiscus form has not been found in cotton, though fields in the vicinity of quite a number of Hibiscus plants showed no Pink Bollworm infestation.

Apart from treating the seed as described in my former letter there is little that can be done by way of control. A close season cannot be enforced, or it could not last year, and there is not sufficient staff for the purpose of widespread scouting. We have to rely on an examination of cotton coming in to the Ginnery for our knowledge of its distribution. Only three gins are in use, so a fairly good record can be kept of any new areas showing Pink Bollworm either in the refuse buckets or in the seed cotton in the bales being opened by the graders. Early in the year the ratoon cotton and the cotton which had been picked from plants allowed to stand over from last year, was swarming with Pink Boll worm. Later pickings are not so badly infested. There was a very severe heat wave about the time the bolls were ripening and much shedding took place and a number of larvae may have been killed in this way, as the surface of the ground was very hot and larvae falling on it exposed to the sun were killed in a few seconds.

One or two places, have however, been very badly hit, especially those in which cotton was ratooned or allowed to stand over.

I think that a vigorously applied legislation, or better still, co-operation on the part of the farmers, would keep the Pink Boll worm in check, but as circumstances are at present, we can only hope to keep the free areas free.

How the original invasion took place must remain forever a mystery. Cotton has been grown in Queensland off and on ever since the American Civil War, so that there has been ample opportunity for Platyedra to have been introduced over and over again.

Mr. Meyrick suggested the possibility of its introduction by Malays 300 years ago. It certainly does look as though it is on the way to form a new species, but differences of the larvae are not reflected in the adults which are all typical *gossypiella*.

This is the situation up to date. All the season's cotton is not in yet, so it is possible that a further spread might be reported.

E. BALLARD, *Cotton Entomologist, Commonwealth of Australia*

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1925

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication, at $2.50 per page for all matter in excess of six printed pages; in the case of other matter, the maximum of 2,500 words is still operative. Photo-engravings may be obtained by authors at cost.

Separates or reprints, if ordered, when the manuscript is forwarded, will be supplied to authors at the rates given below. Note that the number of pages in a reprint may be affected somewhat by the make-up, and that part of a page is charged as a full page. Carriage charges extra in all cases. Shipment by parcel post, express or freight as directed.

One hundred separates or reprints at $1.50 per page or plate. Additional hundreds or less, 4 pages or less, $1.00; 5–8 pages, $1.50; 9–12 pages, $1.75; 13–16 pages, $2.00; 17–24 pages, $3.00; 25–32 pages, $4.00. Covers suitably printed on first page only, 100 copies, or less, $4.50; additional hundreds, or less, $1.75. Plates inserted, $1.75 per hundred, or less. Folio reprints, the uncut folded pages (50 only), sixteen page signature, or less, $3.00. A discount of 10 per cent and 20 per cent from the above prices will be allowed on orders of 500 and 1000 reprints respectively.

It looks a little as though scientists were too far in advance of the times, if the developments at the Scopes trial are an indication. A philosophy of life which fails to account for multitudes of well known facts can not satisfy the honest inquirer. It is quite likely that many of our fundamentalist friends would be evolutionists were they fully acquainted with the facts. Some have probably outgrown the belief in a personal Santa Claus. Many fail to realize the recent enormous developments in knowledge regarding man, other animals, plants, the earth and the solar system and are unable or unwilling to inform themselves regarding these matters. Not a few are resting secure in interpretations of forebears who knew little or nothing of comparative anatomy, of the wealth of life in its multitudinous forms, of the histories of peoples, of comparative philology, etc., and by the same token the marvels of electricity and its applications in modern development. Yet these people do not hesitate to take full advantage of the material developments following in the wake of learning, and refuse, practically speaking, to adopt the same course in relation to intellectual and spiritual matters. No arguments can change the facts. The progress of the world is dependent to a very large degree upon the correct interpretation of religious and spiritual values. Is it not possible for fundamentalists and evolutionists to reason this out on a friendly basis? Both are seekers of truth.

The Report of the Rockefeller Foundation for 1924 is a most interesting document to the economic entomologist. The progressive elimination of yellow fever illustrated on page 27 is a striking example of entomology and medicine cooperating for the alleviation of one of the

major ills to which human flesh is heir. The foundation has been able so secure coöperation probably to a much greater extent than would have been possible for any other agency. It is interesting to recall that the entomological foundations for this beneficent work were laid by Dr. L. O. Howard and his late associate, Dr. John B. Smith. The former enjoys a well earned, world-wide reputation. The work of the latter has made New Jersey famous for its mosquito control operations. The Rockefeller Foundation is also conducting extensive studies and demonstrations in malaria control on an international scale. We can no refrain from mentioning the hookworm work though it can not be classed as an entomological project. It should be noted that the Foundation has underwritten Biological Abstracts for a ten-year period and pledged for this purpose the sum of $350,000. It recognizes in this manner the necessity of giving investigators ready access to the sources of information. This latter step, as we come to realize the great complex of publication agencies, may be followed by a few combinations and a greater ease in keeping track of information. Facts can not be too accessible. The desire of the Foundation to be the servant in a common cause may well serve as an inspiration to all investigators.

Review

A Monograph of the Plecoptera or Stoneflies of America North of Mexico by J. G. NEEDHAM and P. W. CLAASEN. The Thomas Say Foundation of the Entomological Society of America, Vol. 2, pp. 1–397, text figures 29, (plates 50), 1925.

This systematic account of a comparatively unknown group is a substantial addition to our knowledge of aquatic insects—a favorite group with the senior author—and also most creditable to the agencies which made the volume a reality. The keys, descriptions, illustrations and bibliography in relation to the 207 species treated make this work indispensable to all students of aquatic insects and a most valuable addition to every entomological library. The volume should also be in many of the larger libraries of the country.

The Thomas Say Foundation is a publishing agency organized for the production of entomological works, the receipts from earlier volumes being used for the printing of others. All interested in science can render a service by purchasing or assist in the early placing of copies of this monograph, thus making possible other volumes. There is an abundance of material. The securing of funds is the cardinal difficulty.

E. P. F.

Current Notes

Messrs. J. Leslie Rogers and Gerald T. Thompson are assisting in the work of nursery inspection at the Connecticut Agricultural Experiment Station.

The next international Congress of Entomology will meet at Zurich from July 19–26 with the Swiss Entomologist, Dr. A. von Schulthess as President.

Dr. J. Hatori, Biologist of Formosa, stopped at the Division of Insects, U. S. National Museum, to study the mite collection and confer with Dr. Ewing.

Dr. A. G. Butler, well known as an entomologist and ornithologist and a former official of the British Museum, died May 28, at the age of eighty years.

Late in June, Doctor E. A. Back visited the Dried-Fruit Laboratory at Fresno, California, surveying the projects under way at that station.

The Dried-Fruit Laboratory was moved on July 17 from 1584 Ferger Avenue to 712 Elizabeth Street, Fresno, California.

Mr. Roger B. Friend of the Connecticut Agricultural Experiment Station took the course of study at the Marine Biological Laboratory, Woods Hole, Mass., July 5 to August 10.

Mr. M. D. Farrar, a graduate student at Iowa State College, Ames, Iowa, has accepted an instructorship at the South Dakota Agricultural College. Mr. Farrar will teach entomology and apiculture.

Mr. C. C. Hamilton, Associate Entomologist of the Maryland Station, was appointed Assistant Entomologist of the New Jersey Station and began his duties May 1.

Mr. J. L. Horsfall, formerly research entomologist of the Pennsylvania State College, accepted a position July 1 as Entomologist with the American Cyanamid Company, of New York City.

At the Pennsylvania State College, Mr. N. E. Phillips, Assistant Professor of Entomological Extension has resigned and Mr. George H. Rea has been appointed to fill the vacancy.

Prof. G. H. F. Nuttall, Dr. Hugh Scott and Mr. W. A. F. Balfour-Browne have been appointed representatives of Cambridge University at the International Congress of Zoology to be held at Zurich in July.

Mr. David E. Fink, Entomologist of the United States Department of Agriculture, Bureau of Entomology, stationed at Riverton, New Jersey, received the degree of Doctor of Philosophy from the University of Pennsylvania on June 17th.

Dr. A. G. Boving of the U. S. National Museum left for Denmark June 9 on the S. S. Lithania. During his sojourn in Europe he will study the Coleopterous larvae in the Copenhagen Museum, British Museum and in certain other collections.

Mr. F. H. Wilson, graduate student of Cornell University, spent about ten days recently in the U. S. National Museum working on Mallophaga in connection with the preparation of a thesis.

Dr. H. L. Dozier, Entomologist of the Porto Rican Experiment Station, spent about two weeks at the Division of Insects, U. S. National Museum, conferring with specialists and examining types of Hemiptera.

According to *Science*, Professor Harold R. Hagan of the University of Utah, was elected president of the Utah Academy of Sciences at a recent meeting held in Salt Lake City.

Dr. A. D. Imms of Rothamsted, England, recently visited the Section of Insects, U. S. National Museum, consulting with various specialists. During his stay in Washington, he was the guest of Dr. Bôving.

According to *Science*, Dr. J. E. Woodsedalek, head of the department of zoology and director of pre-medical and graduate studies at the University of Idaho, has been made dean of the graduate school.

Dr. B. M. Harrison of Iowa State College, Ames, Iowa, has accepted a position as associate professor of zoology at the University of Southern California, Los Angeles, Cal. Dr. Harrison will teach zoology and economic entomology.

Dr. E. P. Felt was scheduled to give a paper before the New York Entomological Society April 7 on Winds and Insect Distribution with Special Reference to the Gipsy Moth in New York State.

Dr. A. Dampf, Government Entomologist of Mexico, started about the middle of July through unknown Yucatan and Guatemala in search of the permanent breeding grounds of *Schistocerca paranensis* and expected to make some interesting entomological observations.

Mr. Arthur Gibson, Dominion Entomologist, left Montreal on May 29 on the S. S. Aurania to attend the second Imperial Conference on Entomology in London June 9, called by the Imperial Bureau of Entomology and the Colonial Office.

According to *Science*, Dr. Paul S. Welch, Associate Professor of Zoology, University of Michigan, has been granted leave of absence for the academic year 1925-1926, and will spend the year in Europe visiting the principal universities, museums, research institutes and biological stations.

Mr. F. L. Gambrell, a graduate student, Ohio State University, has been appointed assistant in research in Entomology (effective May 1) at the New York State Station to fill the vacancy caused by the transfer of F. G. Mundinger to entomological work in the Hudson River Valley.

Don Fernando Silvela, Agricultural Attache of the Spanish Embassy, visited the Division of Insects, U. S. National Museum, especially to renew his acquaintance with Dr. Mann, with whom he became acquainted when Dr. Mann was in Spain last year.

Mr. Walter Carter, who was appointed temporary Assistant Entomologist at Lethbridge on April 1 by the Civil Service Commission, resigned his appointment before reporting for duty to take a more advantageous post with the U. S. Bureau of Entomology.

The following recent appointments have been announced in the Bureau of Entomology: L. G. Baumhofer, Field Assistant, Forest Insect Investigations, Halsey Plantations, Nebraska National Forest; E. W. Davis, Kansas Agricultural College, onion maggot investigations, Madison, Wis.; A. C. Kirkpatrick, Collaborator, California.

Mr. George Decker, a graduate student in entomology at Iowa State College, Ames, Iowa, has accepted a position as entomologist for the Georgia State Depart-

ment of Agriculture. Mr. Decker is working on the biology and control of pecan insects.

The first definite record of the sugarcane moth borer in the region of Cairo, Ga., has been furnished by Dr. P. A. Yoder, of the Bureau of Plant Industry, who brought a living specimen to the Bureau of Entomology for identification.

Mr. L. H. Worthley, in charge of the corn-borer control operations, Bureau of Entomology, visited Cleveland and the western area during the week of April 6 to consult State officials and arrange plans for the control work during the approaching season.

During April, Dr. A. L. Quaintance visited the peach-insect laboratory of the Bureau of Entomology at Fort Valley, Ga., and the citrus-insect laboratory at Orlando, Fla., for consultation with the men in charge of the various phases of the work.

According to *Science*, Dr. William M. Mann, formerly Entomologist in the Bureau of Entomology, U. S. Department of Agriculture, will succeed Dr. Alexander Wetmore as superintendent of the National Zoological Park. Dr. Wetmore has recently been appointed assistant secretary of the Smithsonian Institution.

At the 24th annual meeting of the North Carolina Academy of Science held at Raleigh, May 1-2, the following entomological papers were read: Some Homoptera from Cuba, by Z. P. Metcalf; Progress on State Insect Survey, with Comparative Data on Other Animal Groups, by F. Sherman.

Messrs. J. R. Horton and J. S. Pinckney, Bureau of Entomology, were recently in consultation with the extension authorities of Oklahoma regarding the serious grasshopper outbreak near Lawton. Mr. Horton has planned to conduct control experiments in connection with the control work undertaken by the State extension authorities.

Professor George M. List, Colorado Agricultural College, Fort Collins, Colorado, who has been taking graduate work in entomology at Iowa State College, Ames, Iowa, returned to Fort Collins July 22. Prof. List, except for writing up his thesis, has completed his work for a Doctor's degree.

According to *Science*, Dr. Richard A. Muttkowski, associate professor of vertebrate zoology at the University of Idaho, has resigned to become professor of biology at the University of Detroit. During July and August he will be in Glacier Park, investigating lakes and streams for the Bureau of Fisheries.

Mr. D. J. Caffrey, in charge of the corn-borer research work, Bureau of Entomology, was located at Oak Harbor, Ohio, for several weeks in early summer co-operating with the Ohio State Experiment Station in extensive plowing experiments to determine the effect of plowing down cornstalks and stubble during the spring.

According to *Science*, Dr. William Schaus of the U. S. National Museum, sailed for France on June 4 to bring to Washington the Dognin collection of moths. Dr. Schaus, who is accompanied by Dr. J. T. Barnes of the Division of Entomology, raised $50,000 by private subscription to purchase the 82,000 specimens in the collection.

Mr. A. G. Dustan, Entomological Branch, Canadian Department of Agriculture, was promoted from Assistant Entomologist under the immediate direction of the Dominion Entomologist to the position of Entomologist on the Division of Field

Crop and Garden Insects, dating from April 1, 1925. This position was made vacant by Mr. H. G. Crawford's promotion on February 1.

Mr. J. C. Hamlin, in charge of the Dried-Fruit Laboratory, conferred with the following visiting scientific men: Messrs. A. P. Dodd, E. Mortensen, and H. Barnette of the American division of the Australian Commonwealth Prickly-pear Board; Mr. Elmer Snyder of the Department's staff on Horticultural Investigations; and Mr. W. B. Camp of the Federal experimental station at Shafter, California.

Messrs. H. L. Sweetman and F. C. Hottes, graduate students at Iowa State College, Ames, Iowa, have accepted positions at the University of Minnesota. Mr. Sweetman is assistant in the Experiment Station and Mr. Hottes is in the department of entomology. Mr. Hottes is making a special study of the Aphididae under the direction of Prof. Oestlund.

Mr. C. R. Twinn, Entomological Branch, Canadian Department of Agriculture, was promoted from Junior to Assistant Entomologist dating from April 1, 1925. This position which was made vacant by Mr. Buckell's promotion last March, has been transferred from the Division of Field Crop and Garden Insects and is now under the immediate direction of the Dominion Entomologist.

Transfers in the Bureau of Entomology have been announced as follows: Perry A. Glick from Federal Horticultural Board to work on cotton aphis at Tallulah, La.; W. D. Whitcomb, from Camphor Scale Investigations, New Orleans, to European corn-borer work, Arlington, Mass.; Rodney Cecil, from Birmingham, Ala., to Geneva, N. Y.; G. L. Garrison, Washington, D. C., to Quincy, Fla. (temporary).

Mr. C. R. Phipps who has recently been pursuing graduate study at Iowa State College has been appointed Associate Entomologist at the Maine Agricultural Experiment Station at Orono, where he assumed his new duties July 1. Mr. Phipps was formerly employed as Assistant Entomologist at the New York State Agricultural Experiment Station and as Entomologist at the Missouri State Fruit Experiment Station.

Miss Grace Sandhouse, graduate student of Cornell University, spent a week in the Section of Insects, U. S. National Museum, studying bees. Most of this time was devoted to a study of the types of the bees belonging to the genus Cosmia. Miss Sandhouse is preparing a revision of the North American species of this genus, to be submitted to Cornell University as partial requirements for a degree of Doctor of Philosophy.

According to the *Official Record*, Dr. E. D. Ball, Director of the scientific work of the U. S. Department of Agriculture, who tendered his resignation to Secretary Jardine in March, has been appointed by the Florida State Plant Board to carry on an intensive study of the celery leaf-tyer in the Sanford and other celery-growing districts of that State. He entered upon his duties August 1. His address is Entomological Laboratory, Sanford, Fla.

According to *Science*, Dr. Vernon Kellogg of the National Research Council, sailed for Europe on June 25, to attend the meeting of the International Research Council at Brussells on July 7 and following days. He will also represent the National Research Council at the meeting of the League of Nations' Committee on International Intellectual Co-operation in Geneva the last week of July, and later will attend the meeting of the British Association for the Advancement of

Science at Southampton as representative of the National Research Council and the American Association for the Advancement of Science.

Hearings were held before the Federal Horticultural Board, Washington, D. C., on June 29–30. On June 29 was considered the further restriction on importations of fruit and rose stocks, and on June 30, changes in the pine blister rust quarantines were considered. The following entomologists were present: J. M. Robinson, Auburn, Ala.; W. E. Rumsey, Morgantown, W. Va.; E. N. Cory, College Park, Md.; W. E. Britton, New Haven, Conn.; Dr. C. L. Marlatt and Mr. E. R. Sasscer of the Federal Horticultural Board, Washington, D. C.

On July 7–9, a party of entomologists and State officials made a trip through the gipsy moth barrier zone which extends from the Canadian border to Long Island Sound. The party gathered at Albany, Monday afternoon, July 6. Those making the trip were: C. H. Hadley, Pennsylvania; Dr. T. J. Headlee, New Jersey; Dr. E. P. Felt, Dr. H. H. York, H. L. McIntyre and S. Phillips, New York; Dr. W. E. Britton and John T. Ashworth, Connecticut; A. F. Burgess and H. L. Blaisdell of the Bureau of Entomology.

Dr. E. A. Back of the Bureau of Entomology was present by invitation at the monthly supper and meeting of the New York Textile Colorists and Chemists, held April 24 at the Stewart Restaurant, New York City. Special interest centered in a motion picture on clothes moths which was made in Germany at the expense of a commercial company interested in one of the so-called mothproofing solutions known as "Eulan." The presentation of the film was accompanied by a talk by Dr. Mullin, a chemist of Camden, N. J.

Mr. George F. Moznette, of the Bureau of Entomology, recently returned from a trip to Argentina and Chile for investigating the distribution of fruit-flies affecting oranges and other fruits. While in Washington, in preparing his report on his trip, Mr. Moznette made use of the National Collection of fruit-flies to obtain data on the distribution of various forms, and consulted with dipterists to obtain identification of material he had collected. The small collection of miscellaneous insects he obtained while on this trip has been deposited in the National Collection.

Mrs. Thomas L. Casey has personally given to the U. S. National Museum a generous sum of money for the purchase of a binocular microscope to be associated with the Casey Collection of Coleoptera, for the use of students who consult this collection. A more than usually complete outfit has been ordered, with several new features. An important part of it is a complete series of objectives, including several of higher power than are at present in the Museum equipment. The money donated for this purpose had been received by Mrs. Casey in the form of Christmas presents from her husband, and it was her wish to use it to provide a special microscope which would be always available for those studying there.

Recent appointments in the Entomological Branch, Canadian Department of Agriculture, have been announced as follows: H. E. Gray, seasonal junior entomologist, Lethbridge; R. D. Bird and R. M. White, seasonal junior entomologists, Treesbank; A. A. Wood, insect pest investigator, Strathroy; N. J. Atkinson, temporary junior entomologist, Saskatoon; F. Jeffrey, seasonal laboratory assistant, Ottawa; T. Owens, laboratory helper, Lethbridge; C. E. Yauch, temporary field assistant, Aylmer, Quebec; Miss M. Bonell, temporary laboratory assistant, Ottawa; A. K. Graham, temporary assistant entomologist, New Brunswick; Norman Cutter,

temporary assistant entomologist. H. H. Thomas, seasonal junior entomologist and K. Auden, temporary junior entomologist, will assist Mr. Hopping in the investigation and control of forest insects in British Columbia; E. A. Sharpe, temporary insect pest investigator, New Brunswick; Messrs. C. Turcot, Rioux, Heon, Leber, R. Letourneau, Paradis, Crawford and Freeman for gipsy moth work in Quebec.

According to *Science*, the following changes have been made at the University of Minnesota. Dr. William A. Riley has been appointed head of the Department of Animal Biology, succeeding Professor Henry F. Nachtrieb, who is retiring at the close of 40 years of service. Dr. Royal N. Chapman succeeds Dr. Riley as chief of the Division of Entomology and Economic Zoology. Both Dr. Chapman and Dr. Riley retain their double membership in the two departments and their work will be closely correlated. Dr. Clarence E. Mickel has been appointed Assistant Professor of Systematic Entomology and Curator of the Insect Collection. Dr. Maynard S. Johnson, of the University of Illinois, has been appointed Assistant Professor of Economic Vertebrate Zoology, and Harvey L. Sweetman, of the Iowa State College, as Instructor in Economic Entomology.

The "Insecta" part of the "Zoological Record" (as distinguished from the complete volume) will in future be published by, and only obtainable from, the Imperial Bureau of Entomology. The price for the part will be 15/–, as heretofore. It is, however, proposed as an experiment to break up a limited number of copies into the following sections, which will be sold as follows: Section A. List of Titles and Subject Index, 4/–; Section B. Coleoptera, 6/–; Section C. Lepidoptera, 6/–; Section D. Hymenoptera and Diptera, 4/–; Section E. Hemiptera, Orthoptera and remaining Orders, 4/–. The above division has been instituted for the benefit of those entomologists who are interested in a portion only of the systematic part of the work. It is in the nature of an experiment only and cannot be continued unless it is widely supported. All orders for the "Insecta" part, or any sections of it, should be addressed to the Assistant Director, Imperial Bureau of Entomology, 41, Queen's Gate, London, S. W. 7. Orders for the complete volume of the "Zoological Record" should continue to be sent to the Zoological Society of London, Regent's Park, London, N. W. 8.

Dr. F. C. Craighead of the Bureau of Entomology spent several days early in April at the Northeastern Forest Experiment Station, Amherst, Mass. Dr. Haven Metcalf, of the Bureau of Plant Industry, was also present, as well as several other specialists interested in northeastern forestry problems. A tentative plan was drawn up for entomological and pathological co-operation with this experiment station The white pine weevil will be the chief entomological problem undertaken by the Bureau. Through the efforts of Dr. R. T. Fisher, of Harvard University, $2,500 has been donated by Massachusetts timberland owners to assist in conducting these studies. Toward the end of the month, Dr. Craighead spent two days at Madison, Wis., discussing with Dr. E. J. Kraus plans for certain investigations which the latter will undertake for the Bureau this summer. Dr. Kraus has been appointed to make a preliminary study of the condition within the tree which affects its susceptibility to bark-beetle attack and influences brood development. It is becoming more and more evident from studies that many species of bark-beetles do not attack indiscriminately any trees in the forest, but that in many cases predisposing conditions within the tree are necessary.

The British Correlating Committee for the Protection of Nature, which is composed of representatives of the Societies in Great Britain (among them being the Entomological Society of London) interested in the protection of animal and plant life, has learned with grave concern of the serious effect on the numbers of certain beautiful species of butterflies in the British Isles resulting from the use of the wings of these insects for jewelry and similar purposes. Some of the most active dealers in these insects are in Canada and the United States. Accordingly the British Correlating Committee and the Entomological Society of London appeal to Entomological and Natural History Societies in Canada and the United States to use their utmost influence to prevent the threatened extermination of the coveted species. Inasmuch as legislation would be difficult both to secure and to enforce, use must be made of moral suasion. The dealers themselves would no doubt be fully alive to the disadvantage from the commerical point of view of a serious diminution in the number of these butterflies, and would be willing to co-operate in any reasonable measures to secure the end in view. For the British Correlating Committee for the Protection of Nature, Rothschild, Chairman, G. F. Herbert Smith, Hon. Sec.-Treas., for the Entomological Society of London, E. B. Poulton, President; S. A. Neave, Hon. Sec.

Apicultural Notes

Mr. William Baker has been appointed deputy inspector of apiaries in North Dakota.

The Wisconsin legislature recently appropriated $10,000.00 for the control of bee diseases and insect pests.

The State Legislature of Illinois has made a biennial appropriation of $36,500 for disease inspection work.

Professor Wallace Park, professor of apiculture, University of Illinois, has resigned to accept a similar position at the Iowa State College.

Mr. M. G. Dadant has resigned as secretary of the Illinois State Beekeepers' Association. His successor is Mr. H. M. Barker, of Centralia, Illinois.

Dr. E. F. Phillips, professor of beekeeping, Cornell University, has recently been honored by being chosen as alumni trustee of Allegheny College, Meadville, Pa., his *alma mater*.

The summer field meeting of the Connecticut Beekeepers Association was held June 20, at the home of Mr. A. W. Yates, Chapman Street, Hartford, with a good attendance.

An interesting bulletin, "Suggestions on Queen-Rearing" by H. B. Parks and A. H. Alex has appeared during the year as Circular No. 35 of the Texas Agricultural Experiment Station.

The annual field meeting of the Ohio State Beekeepers' Association will be held at Delphos, Ohio, on August 20, at the queen-rearing yard of Fred Leininger, twelve miles west of Lima on the Harding Highway.

The third summer meeting of the North Dakota Beekeepers' Association was held June 24 at Devils Lake. The speakers were C. G. Mathews, St. Paul, Willis L. Crites, Amenia, Dr. M. C. Tanquary, Fargo, and J. W. Lawton of Canada.

The Missouri Board of Agriculture has been compelled to discontinue the office of State Apiarist, and apiary inspection work on account of the failure of the last legislature to renew the appropriation. This leaves Missouri in the unfortunate position of being without inspection work in the State.

Dr. A. P. Sturtevant, of the Bee Culture Laboratory of the Bureau of Entomology, spoke before the meeting of the Maryland Beekeepers' Association held at Forest Glen, Maryland, on May 23, and with the assistance of Mr. E. L. Sechrist gave a demonstration of how to treat a colony affected with American foulbrood.

"The Flight Activities of the Honeybee" by Dr. A. E. Lundie, now of South Africa, has appeared recently as Department Bulletin 1328 of the United States Department of Agriculture. The research work described in this bulletin was carried on by Dr. Lundie while in this country for the purpose of graduate study at Cornell University.

Numerous colonies of bees infected with the bee louse, *Braula coeca*, have recently been found in Australia and Tasmania. In these countries in the past it was thought, as in the United States, that the climate was not suitable for this insect to gain a foothold. As yet, however, it is not thought that these outbreaks will prove very harmful.

The following temporary appointments have been made at the Bee Culture Laboratory of the Bureau of Entomology: Junior Biologist in Apiculture, Prof. L. M. Bertholf, of Western Maryland College, and Mr. Carlton E. Burnside, a graduate student at the University of Michigan; Assistant Scientific Aid in Apiculture, Miss Winifred S. Hull, a student at Vassar College. Mrs. Mary Katheryn Lindell, of Ocean View, Delaware, has accepted a temporary appointment as Field Assistant at the temporary field laboratory, Indian River Inlet, Delaware.

A honey and bee program was arranged for the Rotary Club luncheon at Anniston, Ala., June 9, by Mr. M. G. Christian, who placed a pound section of Melilotus honey by the plate of each member of the Club and a demonstration hive containing frame of brood, honey, worker bees, drones and queen was exhibited. Professor J. M. Robinson gave a twenty-five minute talk in which he explained the organization of the bee colony, the movable frame hive, queen-rearing and the bee industry of Alabama.

Among recent visitors at the Bee Culture Laboratory were: Mr. Virgil Argo, a graduate student of Cornell University, Dr. R. L. Parker, and Dr. E. F. Phillips. Doctor Parker is temporarily employed with the Co-operative Boll Weevil Control Investigations, of the Bureau of Entomology, for the purpose of determining whether bees are affected by the application of poisoned molasses bait used on cotton. In the fall he will assume his duties at Kansas State Agricultural College as successor to Dr. J. H. Merrill who is now engaged in commercial beekeeping.

At the 52d Annual Convention of East Tennessee Farmers' Institute, Knoxville, a section in beekeeping was given with the following program. This section had a large attendance and keen interest was manifest throughout the program, which consisted of discussions, demonstrations and a question box: Equipment and Management of the Home Bee Yard, by W. L. Walling, State Apiary Inspector; How to Detect and Control Brood Diseases, G. M. Bentley, Entomologist, University of Tennessee; Transferring Bees from an Old to a Modern Hive, J. D. Humphries, Fellowship Student, University of Tennessee; Selecting Honey for Exhibition at Fairs, Mrs. Lily Crouch, Practical Beekeeper; and Uniting Weak Colonies, E. E. Haegler, Student in Beekeeping, University of Tennessee.

Horticultural Inspection Notes

Mr. Allen G. Harley, an inspector of the Federal Horticultural Board, was transferred from New York City to Baltimore on June 27th.

Larvae of the Mediterranean Fruit Fly (*Ceratitis capitata* Wied.), have again been collected by inspectors of the Federal Horticultural Board in several lots of loquats arriving at Boston and at Providence, R. I. The infested fruit all came from the Azores.

Mr. Henry W. Hecker, who formerly assisted in the inspection work at New York City, was transferred to Chicago, Illinois, May 1st and is in charge of the Board's work there. He may be addressed in care of the Collector of Customs, 450–454 Federal Building.

Mr. Lee A. Strong, who has been in charge of the Plant Quarantine Inspection Service of the Federal Horticultural Board, has resigned his position to enter again the service of the State of California. He is now Assistant Director of Agriculture and is located at Sacramento.

Mr. W. V. Reed, who was appointed by the Board on March 10th, 1924, New Orleans, Louisiana, and transferred to Washington, D. C., on September 16th, 1924, resigned May 15, 1925. It is understood that Mr. Reed contemplates engaging in the nursery business near his home at Laurel, Mississippi.

Messrs. Charles E. Cooley and Geraldus Gay, who were formerly stationed in New York, sailed for San Juan, Porto Rico, on May 28th to handle the necessary inspection work for the Federal Horticultural Board. Mail will reach them for the present addressed in care of Doctor Carlos Chardon, Commissioner of Agriculture and Labor, San Juan, Porto Rico.

Mr. Perry A. Glick was transferred from the Federal Horticultural Board to the Bureau of Entomology, April 27th. He had been employed by the Board at New York City from November 12th, 1923, except for temporary assignments in Washington, D. C., and St. Louis, Missouri. Under his new appointment, Mr. Glick will be stationed at the laboratory of the Southern Field Crop Insect Investigations, Bureau of Entomology, Tallulah, Louisiana.

Larvae of a Curculionid, which could not be identified by specialists of the Bureau of Entomology, were taken from dahlia roots from Italy at New York on April 7th. The following note in regard to the insect was made by the specialist: "Dahlia roots are as a rule remarkably free of injurious Coleopterous larvae. This is the first time Curculionid larvae from roots of dahlia have been submitted to me for determination, and I have not been able to find anything in the literature referring to such infestation."

Dr. C. L. Marlatt recently left Washington on a trip which will take him through the Mediterranean countries of Europe. While in Spain and France he will investigate the Mediterranean Fruit Fly situation, with a view of obtaining first hand information on the distribution of this insect and on the kinds of fruit which it attacks. The Spanish Government desires advice on methods of control or eradication which will prevent infestation of the Almeria grape and other fruits which it desires to export to the United States.

A weevil which attacks the tubers of yams was taken by an inspector of the Federal Horticultural Board at New York City, April 17th, in yam from Haiti. It was identified as *Palaeopus costicollis* Marshall (Curculionidae). The specialist states that this name has priority over the name of *P. dioscoriae*, under which the insect was described in Vol. XII, No. 9, Journal of Agricultural Research. The Board has several records of this insect having been taken in yams from Jamaica, but this is the first time it has been found in yams from Haiti.

The following men have received appointments as Junior Plant Quarantine Inspectors with the Federal Horticultural Board at the port of New York during the months of May, June and July: Mr. Frederick A. Hodges, a graduate of Syracuse University in 1923; Mr. Spencer A. Mann, a graduate of the University of Minnesota; Mr. George A. Samouce, a graduate of the Virginia Polytechnic Institute; Mr. John H. Painter, a graduate of the University of Maryland and the Oregon Agricultural College; Mr. Raymond A. Fox, a graduate of the University of Delaware.

An inspection of the cargo made up in part of 1027 oak logs which arrived at San Francisco from Japan on the S. S. Kongosan Maru in April by California State Inspectors revealed the presence of an eggmass of the Gipsy Moth (*Porthetria dispar*), together with several insects of lesser importance. The importers were notified of the findings and they advised the Japanese authorities and the exporters. It is hoped that all future shipments of logs from Japan will be made after removing the bark. All of the rough bark from this shipment was ordered burned at the mills as soon as removed.

As a step toward keeping certain injurious fruit and vegetable insects, including the West Indian fruit fly (*Anastrepha fraterculus* Wied.) and the bean pod borer (*Maruca testulalis* Geyer), out of the United States, the Secretary of Agriculture has placed a quarantine (which became effective July 1, 1925) prohibiting the entry of certain fruits and vegetables and restricting the entry of others from Porto Rico. Provision is made for the unrestricted entry of grapefruit, oranges, and other citrus fruits, pineapples, bananas, plantains, avocados, dasheens, and onions without permit, but under certification. This certification will be based on field and packing house inspection by representatives of the Federal Horticultural Board in Porto Rico. Provision is also made in the rules and regulations which govern such shipments for the addition of other fruits and vegetables to be certified for movement to the United States when it can be shown to the satisfaction of the Department of Agriculture that such fruits and vegetables are not likely to be the means of carrying injurious insects, including the West Indian fruit fly or the bean pod borer. This quarantine leaves in full effect Quarantine No. 30, which prohibits the movement from the Territories of Hawaii and Porto Rico into or through any other Territory, State or District of the United States of all varieties of sweet potatoes and yams (*Ipomoea batatas* and *Dioscorea* spp.) on account of the possibility of these tubers being infested with the sweet potato weevil and the sweet potato scarabaeid. To carry out the provisions of the new Quarantine No. 58, the Board has established an office at San Juan, Porto Rico.

Notes on Medical Entomology

Drs. Samuel T. Darling and Norman Lothian, members of the League of Nation's Malaria Commission, were killed in an automobile accident near Beirut, May 20.

According to *Science*, Dr. Giovanni Battista Grassi, director of the Institute of Comparative Anatomy in the University of Rome, noted for his experiments on the control and prevention of malaria, died May 4, aged 71 years. He was a member of the Italian Senate.

Early in July, Dr. G. E. White and Mr. W. E. Dove, of the Bureau of Entomology, went to Jacksonville, Fla., where they will continue investigations of the human malady known as creeping eruption, in co-operation with Dr. Kirby-Smith of that city. Arrangements are being perfected for the holding of a public clinic in the district, in co-operation with the Florida State Board of Health. It is hoped that a large number of cases will, by this method, be brought under observation, and treatment, as was the case during a similar clinic held last year, in which 180 patients reported, and their cases were studied. A report on last season's investigations was made before the annual meeting of the American Medical Association held at Atlantic City in May.

THE SIXTH ANNUAL MEETING OF THE NORTHEASTERN ENTOMOLOGISTS

The sixth annual meeting of the Northeastern Entomologists was held in the vicinity of Washington July 28, 29 and 30. During the first day, the experimental farms of the Department of Agriculture at Arlington, at Falls Church, and Vienna Laboratories were visited. At the Arlington Farm short talks on the work there were given by Mr. Butterfield, Superintendent of the Farms, and various other Department men. At Falls Church Station, Messrs. N. A. Cobb, and William Middleton gave short talks. At the Vienna Laboratory Mr. W. S. Abbott, in charge of the station, explained the work in progress. After lunch in Washington a large proportion of the visiting entomologists made the trip to Mt. Vernon.

In the evening an informal supper and joint meeting with the Entomological Society of Washington was held, short talks being given by Messrs. Burgess, Caffrey, Britton, Peterson, Hough, Graf, and L. B. Smith. A letter from President Gossard of the American Association of Economic Entomologists was read and discussed by several members; on motion, President Cory as Chairman of the meeting was instructed to acknowledge President Gossard's letter and to advise him that the matter was being given consideration. Committees were appointed as follows:

Resolutions, Britton, Graf, and Hough; Nomination of Officers, Burgess, Moore, and Ross; to select meeting place for next year, Caffrey, Peterson and Hadley. About sixty men were present for the supper which was thoroughly enjoyed by all.

On the second day of the meeting, the laboratories at Somerset, Sligo, the University of Maryland at College Park, and the Bureau of Animal Industry Farm at Beltsville were visited. At the Bee Laboratory at Somerset luncheon was served by the ladies of one of the local churches. During the course of the luncheon the various

committees reported; the Nominations Committee recommended the selection of Dr. T. J. Headlee of New Jersey as Chairman for the next year's meeting, and Professor P. J. Parrott of Geneva, New York, as Secretary. On motion the report of this committee was accepted and these gentlemen duly elected. The Committee on selection of place for next year's meeting recommended that the trip include the mosquito, blueberry and cranberry work in North Jersey, and a visit to the Boyce Thompson Institute at Yonkers. The recommendations of this committee were accepted on motion of those present and the committees for next year were duly instructed. The Resolutions Committee gave the following report:

REPORT OF COMMITTEE ON RESOLUTIONS

Resolved, That the thanks of all visiting entomologists are hereby extended to the officers and local committees in charge of this meeting; especially are we grateful to the management of Arlington Farms, to Dr. Cobb of the Bureau of Plant Industry for the interesting and instructive exhibits seen yesterday; to the Ladies Club of Somerset for furnishing luncheon today to many members of the Bureau of Entomology and others for supplying transportation to the various points of interest.

WHEREAS, the matter of additional branches and sections of the American Association of Economic Entomologists will soon be under consideration, we hereby recommend that the incoming Chairman appoint a committee of three to report at the next summer meeting on the advisability of the Northeastern Entomologists constituting a branch or section of the American Association of Economic Entomologists.

The report of this committee was accepted on motion of those present.

The party returned to Washington late in the afternoon of Thursday, and most of those present went to Frederick, Maryland, for the evening.

The party assembled Friday morning at Frederick, Maryland, to join in with the Maryland State Horticultural Society in a trip over the orchard district of that portion of Maryland. However, owing to the heavy rain fall of the night before and throughout that day, it was necessary to change the plan. A joint meeting was held with the members of the Maryland Horticultural Society, and during the course of the meeting, in a round table discussion on various insect problems, a number of entomologists made reports and answered questions from the audience.

A partial list of those attending the meeting is as follows:

J. M. Aldrich, A. C. Baker, A. N. Caudell, J. E. Graf, J. A. Hyslop, N. E. McIndoo, C. H. Popenoe, A. L. Quaintance, Chas. H. Richardson, S. A. Rohwer, E. R. Sasscer, E. H. Siegler, Joe S. Wade, Wm. H. White, W. B. Wood, C. G. Woodbury, Washington, D. C.; L. R. Cagle, Leesburg, W. S. Abbott, Julian J. Culver, Vienna, W. S. Hough, McSherry Lupton, Winchester, Va.; Benj. B. Jones, Carrollton, Robert C. Burdette, P. Simmons, Silver Spring, E. A. Cory, P. D. Sanders, H. H. Shepard, College Park, Md; C. O. Thomas, Bustleton, Chas. C. Hill, Carlisle, T. L. Guyton, C. H. Hadley, Harry B. Kirk, J. N. Knull, Floyd F. Smith, F. M. Trimble, Harrisburg, J. R. Eyer, North East, J. G. Sanders, Philadelphia, G. F. McLeod, H. N. Worthley, State College, Pa.; H. A. Ames, Bound Brook, R. Hutson, C. A. Stearns, New Brunswick, David E. Fink, J. L. King, Alvah Peterson, L. B. Smith, C. W. Stockwell, Riverton, N. J.; J. R. Horsfall, Wm. Moore, New York, N.Y.; W. E. Britton, New Haven, Conn.; H. L. Blaisdell, C. W. Collins, D. Jeffrey, J. A. Miller, J. V. Schaffner, Jr., Melrose Highlands, Mass.; Virgil N. Argo, Walla Walla, Wash.; Wm. R. Ross, Vineland Station, Ont.; and H. T. Osborn, Los Mochis, Sinaloa, Mexico.

ERRATA

Page 424, line 33, for The water itself read The soap itself.

Page 456, lines 6 and 9, for Liederman read Needham.

Page 509, line 15 from bottom, for Floyd T. Smith read Floyd F. Smith.

Page 512, line 1, for *ribis* read *rubi*.

Page 530, line 16 from bottom for (H) read (L).

Page 531, line 27, for (C) read (L).